FOREST RESEARCH

1925-1926 IN INDIA

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Progress Report of Forest Research Work in India

For the Year 1925-26

Including the Administration Report of the Forest Research Institute, Dehra Dun.

CALCUTTA: GOVERNMENT OF INDIA
CENTRAL PUBLICATION BRANCH
1927

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This Report is printed on paper made at the Forest Research Institute, Dehra Dun, from *Melocanna bambusoides* bamboo. (*See page 82, last paragraph.*)

Progress of Forest Research in India, 1st April 1925 to 31st March 1926.

CHAPTER I.

GENERAL.

1. In the two most important branches of Forest Research, silviculture and utilization, marked progress was made in the provinces and at the Central Institute during the year under report.

The conditions under which the most important timber trees of India should be grown and the question of their natural regeneration have received much attention, especially at Dehra Dun, in Burma, in Madras, and in the United Provinces, and the knowledge possessed by forest officers of the requirements of Indian species is increasing rapidly.

In Burma and Bengal and at Dehra Dun great progress in Research in utilization or forest economy must be recorded.

In the smaller branches, forest entomology, forest botany and chemistry also important additions to our knowledge were made. Most of the work under these heads was carried out at Dehra Dun, but a good deal of forest botanical research was carried out in Burma.

Details are given in the following chapters.

2. During the year 1925 all the senior officers at the Forest Research Institute, including the President, were changed and a certain amount of interruption in progress was unavoidable. This has, however, not proved very serious and experimental work and the publication of results have been successfully carried on in all the branches.

3. Mr. S. H. Howard, I.F.S., went on leave in December 1925, but before doing so he completed a number of most valuable Records which give the results of the work carried out during his service at

Dehra Dun. Mr. Howard's scientific knowledge and industry have supplied to the department an indispensable collection of information on silvicultural subjects.

Mr. Howard was succeeded by Mr. H. G. Champion, I.F.S., also of the United Provinces, who has carried on the work very ably. Mr. Parma Nand from the Punjab has been a most useful assistant in this branch.

Photographic facilities in the Institute have been improved.

4. In the large and important Economic Branch Mr. H. Trotter, Deputy Conservator of Forests, Burma, and Mr. C. C. Wilson, Conservator of Forests, Madras, held charge for eight and four months respectively. Mr. Trotter was very successful in carrying on the work on the numerous lines started by Mr. R. S. Pearson who retired on April 1st, 1925, and Mr. Wilson has made excellent progress since he joined in December 1925.

Work is carried on under the Forest Economist in seven important sections.

Mr. L. N. Seaman was absent on leave during about six months of the year under report and during his absence Mr. Ranganathan, I.F.S., Madras, held charge of the Timber Testing section in which work made good progress under both officers. In addition to the collection of a mass of valuable data on Indian timbers, assistance was given by Mr. Seaman to others, for example the Air Force, in the solution of their problems.

The Seasoning section was in charge of Mr. S. Fitzgerald except for five months when he was on leave and Dr. S. N. Kapur held charge. To both of these officers much credit is due for the advance in our knowledge of the conditions governing the seasoning of Indian timbers. Several tours were undertaken by these specialists to give advice to Railways and others in seasoning problems.

The Wood Preservation section was in charge of Mr. J. H. Warr throughout the year and he has provided us with the results of much valuable experimental work, especially in connection with sleepers for Indian Railways. He was assisted by Mr. S. Kamesam.

Mr. W. Raitt remained in charge of the Paper Pulp section throughout the year and was ably assisted by Mr. M. P. Bhargava. Experimental work at Dehra on the possibilities of the utilization of bamboo and other forest products for the manufacture of pulp have given most valuable results and tours undertaken by Mr. Raitt have helped the provinces in schemes for the utilization of immense areas of bamboo forest.

In the Wood Working section Mr. W. Nagle has done exceedingly good work in the experimental utilization of Indian woods, in training carpenters, and in veneer work, especially for the panels in the new buildings at Delhi.

It is very gratifying to note that the interest of the Indian public, of the Indian Railways, of firms in India, and of enquirers from other countries in the work of these sections is steadily growing year by year and the officers in charge are constantly asked for their advice.

In the remaining two sections, Wood Technology and Minor Products, progress has been slow because no officers were available to take charge of them. A certain amount of work has, however, been done by the Forest Economist and his Assistant and by the other officers of the branch. Mr. F. D. Ardagh, I.F.S., Madras, was appointed to the charge of the Minor Products section in April 1926 and it is hoped shortly to train a wood technologist. This post is a most important one and must be filled.

Mr. Ram Das Tandan deserves credit for the ability with which he has kept in running order the machinery of the branch.

5. Mr. R. N. Parker, Conservator of Forests, Punjab, was in charge of the botanical branch for ten months, and he and his assistant Mr. B. L. Gupta completed a great deal of valuable systematic work. Much progress has been made under these two able officers and they have also done a great deal of arboriculture at the new Forest Research Institute. Mr. Abdul Hafiz Khan has continued to do useful work on Forest Mycology.

6. Dr. C. F. C. Beeson, I.F.S., Punjab, was in charge of the entomological branch for 9 months and Mr. D. J. Atkinson, I.F.S., Burma, for the remaining three. Much progress was made in the collection of data regarding the life history of insects which damage trees and several forests were visited, while our knowledge of systematic Indian Entomology has been largely added to by Mr. J. C. M. Gardner, Systematic Entomologist. Mr. N. C. Chatterjee has also done useful work. The repute of this section is spreading rapidly in entomological circles throughout the world.

7. During half the year the chemical branch was under the charge of Mr. M. Gopal Rao. Both he and Dr. J. Sen who returned from leave as Bio-Chemist in February 1926 have carried out much useful research in forest problems, and in assisting other branches. Mr. T. P. Ghose has proved a very able assistant and was in charge of the branch for four months.

8. The east wing of the new Forest Research Institute was almost completed by the end of the year under report and was occupied

in June 1926 by the Forest Economist and the Forest Entomologist. Work is proceeding on the central block for the west wing and it is expected that the whole building, which will be the finest Forest Research Institute in the world, will be ready in 1929. Most of the quarters for the staff which are ready have been occupied and work on the others is going ahead. A new electrical plant will be erected by the Mussoorie Hydro Electric Company in the grounds of the new Institute. Roads and lawns have been laid out and many home and exotic trees have been planted under the guidance of the Forest Botanist. The old main building of the Forest Research Institute at Chandbagh has been mostly converted into a College for training the Indian Forest Service students from November 1926, but the Silviculturist still occupies part of it and the Botanist and Bio-Chemist have their offices and laboratories in old buildings near by.

The following statement gives the figures showing the expenditure up to the end of March 1926 on the new Forest Research Institute:—

Head.	Expenditure up to March 31st, 1925.	Expenditure during 1925-26.	TOTAL.
	Rs.	Rs.	Rs.
1. Main Building	2,11,000	6,90,109	9,01,109
2. Residential Buildings	6,33,000	21,715	6,54,715
3. Economic Section	6,91,000	40	6,91,040
4. Roads and Bridges	1,27,000	3,731	1,30,731
5. Grass, walls, surface drainage, sewers, water supply, preliminary expenses, electricity, temporary quarters, machinery, light, railway, etc.	14,10,000	1,66,222	15,76,222
6. Land	12,88,000	120	12,88,120
TOTAL .	43,60,000	8,81,937	52,41,937

9. In Appendix V is given a list of publications issued and in the Press up to date. The more important of the publications of the year under review, as given in full in Chapter VII, are—Dr. Brown's Manual of Wood Technology, Mr. Simmons' Manual of Forest Mensuration, Mr. Howard's Yield and Volume Tables, Mr. Champion's note on twisted fibre in trees, Mr. Warr's notes

on the treatment of sleepers, and Lecture Notes for the students. The publications of the Institute are in constant demand from all parts of the world.

10. The President wishes to acknowledge the great help given to him in the training of the students at the College by the Research Officers and their Assistants. It is not too sanguine to express the hope that, while the Research Institute goes on increasing its reputation among the public for sound practical knowledge, we may at the same time, with the help of the Research Officers, establish a first class Tropical School of Forestry.

CHAPTER II.

SILVICULTURE AND WORKING PLANS.

(HEADING UNDER WHICH THERE IS NOTHING TO REPORT ARE OMITTED.)

Central Institute.

I.—Experimental Silviculture.

(*i*) *General.*

Experimental work on seeds, seedlings and artificial regeneration has continued on a relatively small scale owing to the lack of staff, the lines of the work undertaken have remained the same as last year, no new investigations having been taken up.

(*ii*) *Natural Regeneration.*

This office now serves as a bureau of information for silvicultural research, and receives from the provinces copies of all reports on existing plots and of the files for all new plots laid out. An effective system of filing to facilitate ready reference is accordingly of special importance, and the system hitherto followed has been overhauled and much improved. Formerly the files of experiments on all sorts of subjects were given numbers serially in order of date of initiation, separately for each division, and filed by provinces and divisions; now the basis of the classification is the species as for all the other sets of records in the office, and for each species, sub-division is by the subject of the experiment just as in the case of the specific ledger files. Finally where there are numerous experiments on the same subject, *e.g.*, the effect of manipulation of the canopy on natural regeneration of *sal*, the geographical arrangement by provinces and divisions in alphabetical order, is adopted, this being again paralleled in the ledger files. It is thus possible now to find at once all the information on the subject quoted without any reference except to the dividers in the file cabinets. Records of 87 new experimental plots have been added during the year bringing the total up to 287 for all provinces.

(*iii*) *Seeds.*

All samples of seed received from various sources for various purposes have been used for correcting and improving the recorded data for the number of seed per unit of weight, plant per cent. etc. The following corrigenda and addenda have been made to Forest Bulletin 41: a new edition of this list of weights of seeds is due and may be produced next year.

Species.	No. of seeds per oz.	No. of weighments.	Remarks.
Acacia arabica	222	15	
,, *Catechu*	1,116	8	
,, *decurrens*	2,205	4	
Albizzia Lebbek	203	6	
Alnus nepalensis	10,600	1	
Amoora Rohituka	55	1	
Anogeissus pendula	4,600	1	Fruits.
Bombax malabaricum	789	6	
Buchanania latifolia	104	4	
Bursera serrata	92	1	
Calophyllum inophyllum	6	3	
Cedrela serrata	6,160	1	
Dysoxylum binectariferum	4	1	
Eugenia Jambolana	44	3	
Fraxinus excelsior	254	1	
Gluta travancorica	2	2	
Gmelina arborea	40	6	Fruits as received.
,, ,, ...	27	1	Dry fruits.

Species.	No. of seeds per oz.	No. of weighments.	REMARKS.
Grewia oppositifolia	352	1	Dry seeds.
Holarrhena antidysenterica	1,147	6	
Kydia calycina	1,600	1	With husk.
Mallotus philippinensis	642	4	
Melia Azedarach	40	6	
Michelia Champaca	467	3	Dry seeds.
Ougeinia dalbergioides	357	3	Pods.
Phyllanthus Emblica	1,920	2	Dry seeds.
Rhododendron arboreum	329,650	2	
Spondias mangifera	8	3	Dry fruits after removal of pulp.
Tecoma undulata	3,495	4	
Tectona grandis	51	13	Variable.
Terminalia tomentosa	15	14	

The following plant per cent. (*i.e.*, the number of seedlings obtained from 100 seeds) and miscellaneous notes recorded during the year are noteworthy:—

Species.	Plant per cent.	Time to germinate.	REMARKS.
Aleurites Fordii	3	1 to 5 months	Seed from plants grown in Kaunli were again tried with poor result indicated.
Barringtonia acutangula	7	4 months	Fruits ripen and germinate in Dehra in November but radicle dies and embryo remains dormant till end of March when it renews growth.
Bombax insigne	28	2 weeks	Seed from Burma. All but very few plants died during cold weather.
Bombax malabaricum	57	1 to 4 weeks	

Species.	Plant per cent.	Time to germinate.	REMARKS.
Cassia renigera	57	4 months	
Eugenia Jambolana	93	1 to 2 months	Several seedlings often arise from a single fruit.
Grewia tiliæfolia	30	3 months	Seed from South Mandla. C. P. Sown in February.
Holoptelea integrifolia	67	2 to 3 weeks	
Melia Azedarach	76	1 month	
Michelia Champaca	18	3 to 4 months	Local seed ripening in December: germination may not yet be complete.
Sapindus detergens	33	2 to 3 months	Seed from South Kanara.
,, ,,	36		Local seed: germination continued till end of August.
Zizyphus xylopyra	20-32	15 months	See note below.

Zizyphus xylopyra.—A series of experiments was made with this species to expedite germination. Extraction of the seed from the stone fruits results in failure to germinate. Removal of pulp seems essential to good germination as is almost invariably the case for fleshy fruits adapted to dispersal by animals. Nicking the stony covering apparently somewhat enhances the plant per cent. but insufficiently to make the procedure worth while, though the highest per cent. was obtained from such nicked fruits. Soaking 24 hours in 1 per cent. sulphuric acid gave approximately the same result as soaking in water only.

The experiment referred to in last year's report concerning the earliest date at which *chir* (*Pinus longifolia*) cones can be collected without detriment to the viability of the seed, was put through to a successful conclusion. The results have been published in Forest Bulletin No. 67 and amply establish the possibility of collecting cones during the cold weather from December onwards when the fellings are in progress, instead of only in March and April when fellings are over and the trees must be climbed; this demonstration is obviously of considerable practical importance to all divisions with *chir* forests.

(iv) *Nursery work.*

The general results of experience gained have been published as noted under the next head.

(v) *Artificial Regeneration.*

The series of sowing and transplanting experiments which have been in progress for the last 2 years were nearly completed during the year under report, and the results have been included in the Notes on Artificial Regeneration in North India, Forest Record, Volume XII, Part 9. The general conclusions are, that no species whether sown, transplanted or put out as cuttings, can compete with the growth which springs up on an ordinary clear-felled area in North India, unless helped by weeding and cleaning, at least the first rains, or perhaps, in the case of a few of the most vigorous species, in the first cold weather: winter transplanting whether of entire plants or of root and shoot cuttings is equally certain to fail unless irrigation is possible or weather conditions abnormally favourable. The notes summarise information on the subject up to date both under general heads and for the species worked with, and it is unnecessary to reproduce them here.

Line sowings were tried of *Acacia arabica, Albizzia ordoratissima, Bombax malabaricum, Buchanania latifolia, Terminalia belerica, Sapindus detergens, Zizyphus xylopyra, Bischofia javanica, Chickrassia tabularis, Grewia tiliæfolia,* and *Lagerstrœmia Flos-Reginae.* Much damage was done by frost, this being very strikingly the case with *Buchanania latifolia*; the line of this species appeared exceptionally good in November but in January every plant was killed back to ground level and many entirely. Other species which suffered badly were *Lagerstroemia, Zizyphus* and *Terminalia.* In the case of *Ougeinia* and *Grewia* the lines were unsatisfactory from the start owing to poor germination, and the experiment was consequently of little value.

Bischofia does well in the nursery and stands moving (though unirrigated plants were all badly frost bitten), and another species freely used further east, *viz., Chickrassia* appears easy to deal with.

(vi) *Reclamation and Afforestation.*

A good many of the *Pinus longifolia* plants which had been got up in the frosty grass blanks in *sal* forest at Zabarkhet near Dehra Dun have been killed by rats, which cut through the roots in excavating their borrows, but trees which have escaped this damage continue to grow well. It is desirable to repeat the experiment on a larger scale, but Zabarkhet is apparently more valuable for thatch grass than it would be under pine, and the New Site afforestation offers a not too dissimilar problem.

Considerable work has been done on the afforestation of the Demonstration Area of the New Site, Kaulagarh, with 5 species.

30 acres were sown up with *Pinus longifolia* in lines 6′ apart after one year's cultivation for agricultural crops: part of the area is inadequately drained and the seedlings failed, but over the greater part there is an adequate percentage of plants surviving, though they cannot be recorded as successful till they have passed through the hot weather. Much damage was done by rats which cut through many plants in tunnelling in the soil and buried many more with the earth thrown up. The Forest Entomologist undertook measures to reduce their numbers and considerable success appears to have been obtained.

In the Sal Working Circle of 8·8 acres, Compartments 1, 6, 9, and 7 were sown in 1924, but the last named failed, apparently owing to unsuitable soil, and the others have done quite well. In 1925, 8 more compartments were sown and their present condition is satisfactory: filling in blanks in compartments 16 and 9 was also done. This working circle is intended to be used for demonstrating coppice or coppice with standards.

The area sown with *Dalbergia latifolia* has largely failed owing to defective seed.

Over another portion of the area it is proposed to attempt to raise teak to give an example later on of a clear felled coupe followed by artificial regeneration. An acre in which entire transplants were put out with *taungya* cultivation has not been a success, but conditions were rather unfavourable and a further trial will be made with root and shoot cuttings. Meanwhile the area is being sown with *Gmelina* to get it under forest as soon as possible, and this species appears to be doing reasonably well.

(vii) *Thinnings and Cleanings.*

No special investigations have been carried out, but the activity in some provinces in the matter of thinning young plantations and crops raised by *taungya* have been specially noted: the age or size at which the first thinning shall be made and its intensity are the crucial points, and the problem is complicated by numerous factors such as degree of weed danger, demands on the time of the staff and possibly frequency of thinnings. The very sudden increase in area

Plate II.

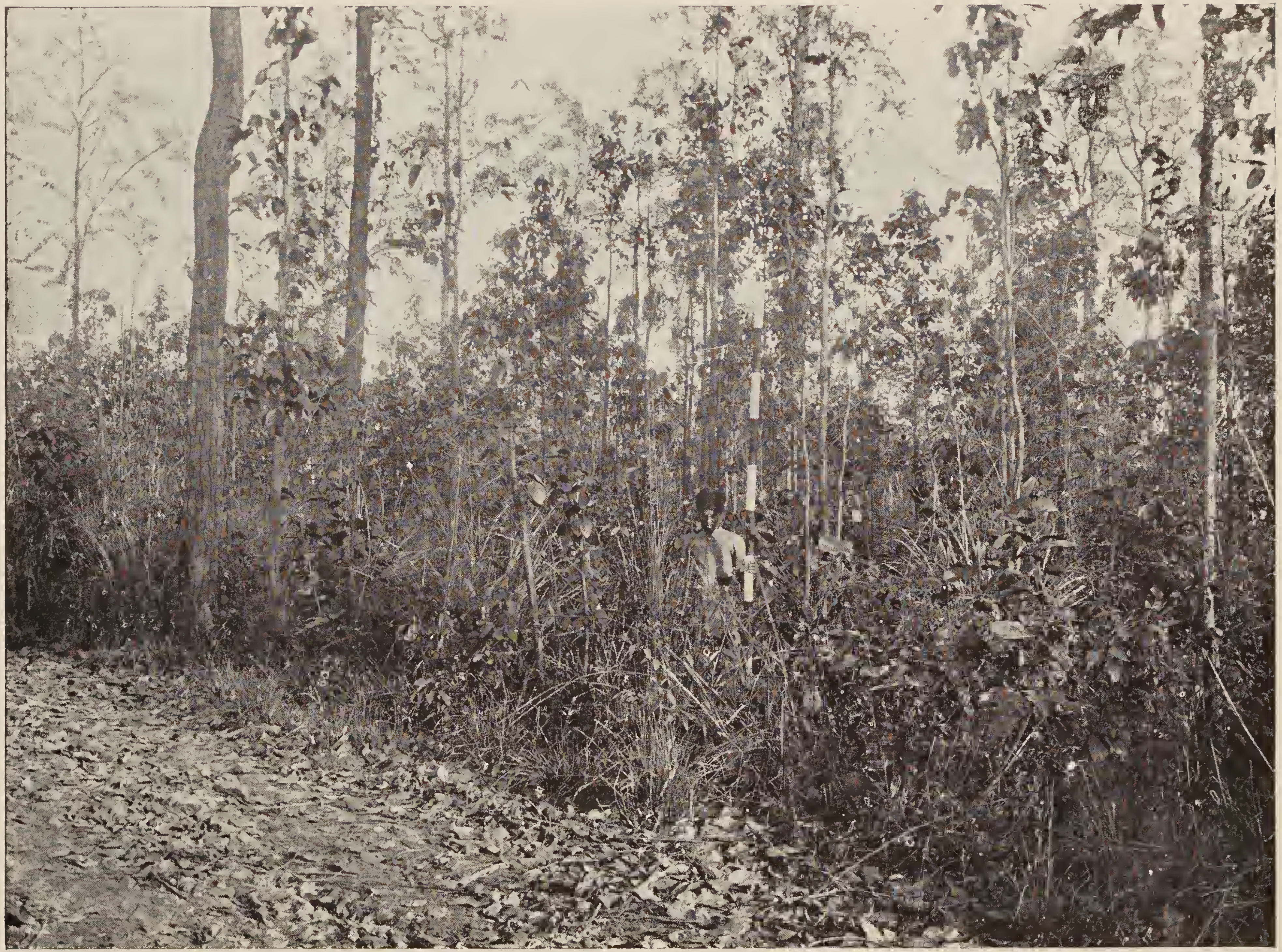

Photo. Mechl. Dept., Thomason College, Roorkee.

Photo. Har Swarup, 8th May 1926.

Sal five years old, average height 22 feet. Compartment No. 7, Lachiwala, Dehra Dun, U. P.

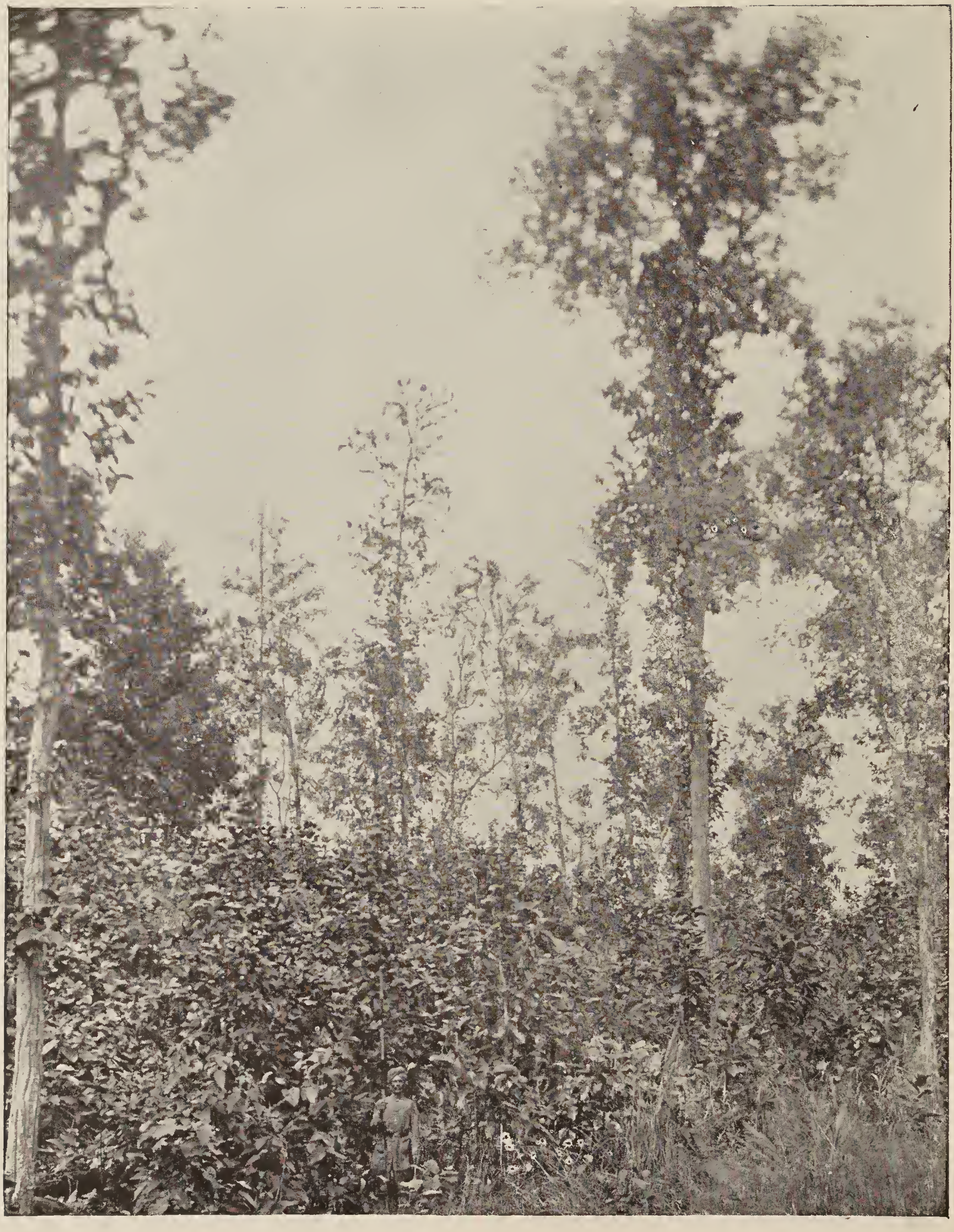

Photo. Mechl. Dept., Thomason College, Roorkee. Photo. I. N. Sharma, June 1926.

Motichur Compartment No. 5, Dehra Dun Division.

Sal two years old, average height 12 feet.

of such artificially raised crops is going to result in difficulties unless staff for tending them is increased *pari passu.*

(*viii*) *Mixtures.*

No special work has been undertaken and the matter is mainly one for local investigation.

(*x*) *Silvicultural Systems.*

In the Dehra Dun Division *sal* regeneration in all stages is profuse over by far the greater part of the area. This is especially noticeable in the more open areas which have been frequently burnt in the past and where grass is the chief undergrowth. In other areas where the stocking is denser, the locality more remote, and where fire protection has been more successful for a long period the undergrowth is chiefly *Clerodendron* and other weeds. In these areas regeneration is very deficient. The chief problem, therefore, has been to devise the best method of utilizing this regeneration. The present procedure in areas where the regeneration is profuse, but suppressed, misshapen, damaged by frost and generally unfit for retention as the future crop, is to reserve a few trees, about 12 to 15 per acre, as shelter from frost and, after removing all the rest of the overhead cover, to cut back all the regeneration close to the ground. The area is then generally burnt departmentally about the middle of March. This has given great success as may be seen from the accompanying photographs. In each case the pole the man is holding is 10 feet long.

Photo on front cover. *Sal* one year old. Burnt on March 13th, 1925. Photo taken on May 8th, 1926. Average height of young *sal* 6 feet.

Plate I. *Sal* two years old. The area was not burnt, but the young crop dates from March 1924. Photo taken on 12th March 1926. Average height of young *sal* 12 feet.

Plate II. *Sal* five years old. Area burnt on April 2nd, 1921. Photo taken on May 8th, 1926. Average height of young *sal* 22 feet.

Material below the sapling stage may be classified as follows:—

1. Small, but not necessarily young, seedlings.
2. Whippy shoots.
3. "Woody advance growth," often very misshapen and suppressed. This is definitely woody but has not yet reached the sapling stage.

The effect of the heavy fellings made and the subsequent cutting back and burning is that:—

1. The small seedlings come up again but do not develop and do not put on annual height growth and so cannot compete with shoots from other material.
2. The whippy shoots behave in much the same way, although in a few cases, in some of the older compartments, some of this material appears to be gradually becoming established.
3. The "woody advance growth" sends up strong shoots which put on annual height growth and quickly grow into well established saplings.

The great majority of the regeneration shown in the three illustrations is derived from shoots from "woody advance growth" and from small saplings.

II.—Working Plans and Statistics.

(i) *Working Plans.*

The following working plans have been received during the year:—

(1) Revised Working Plan of the *Chil* Forests of the Lower Siran Range, Siran Division, Hazara, North-West Frontier Province for 1923-24 to 1942-43, by E. A. Greswell.

(2) Working Plan for Delta Forest Division, Burma, for 1924-25 to 1933-34, by A. W. Moodie.

(3) Working Plan for the Pilibhit Forest Division, United Provinces, for 1923-24 to 1932-33, by W. T. Hall.

(4) Revised Working Plan for the Tulsipur Reserved Forests in Gonda Forest Division, Eastern Circle, United Provinces, for the period 1923-24 to 1932-33, by D. Stewart.

(5) Third Working Plan for the Kalimpong Forest Division, Bengal, by J. M. Cowan.

(6) Revised Working Plan for the Gund Working Circle, Kanara Western Division, Bombay, by R. A. Hemmadi.

(7) Working Plan of the Scrub Forests of the Bijapur District, Bombay, by T. N. Koppikar.

(ii) *Yield Tables.*

The number of new sample plots laid out during the year was 144 (97 permanent and 47 temporary) as compared with 100 last year; out of these 42 were laid out by the Central Institute in Simla and Bashahr Divisions of the Punjab, and the remaining 102 by different provinces. The total number of permanent plots now on the list, after deduction of 60 which have been discontinued for various reasons, is 751: there are in addition 260 temporary plots which are measured once only.

The number of plot files received at the Institute for calculations was 250, against 230 in 1924-25 and 130 in 1923-24. In addition to the working up of these plots, the records of all the *sissoo, sal, ban oak, chir* and *deodar* plots were examined and the calculations were checked as a preliminary to the preparation of yield tables.

In the summer of 1925 all the old sample plots in Bashahr Division (Punjab) were remeasured by the Institute staff and in addition 35 new *deodar* plots of 80 years and above of all qualities (to fill up the gaps in the *deodar* crop data), 4 blue pine and 3 silver fir sample plots in Bashahr and Simla Divisions, were also laid out.

A preliminary yield table for *Dalbergia Sissoo* was published during the year. Yield Tables for clear-felled *sal* (*Shorea robusta*) coppice, *Pinus longifolia*, and *Cedrus Deodara* were also compiled and sent to the Press, and were published after the close of the year.

There are practically no sample plots of *Pinus excelsa* older than 60 years. A tour in Lower Bashahr, Seraj and Kulu Divisions of the Punjab is now being arranged and it is hoped that sufficient data to permit of issuing a yield table will be obtained.

(iii) *Volume and Form Factor Tables.*

The volume and outturn tables for *Shorea robusta* compiled last year were published. Standard and commercial Volume Tables for *Pinus longifolia* and *Cedrus Deodara*, arranged by 20 feet height classes and in three locality quality classes, were prepared and sent to the Press. The set of Volume and Yield Tables for *Shorea robusta, Pinus longifolia* and *Cedrus Deodara* are now complete, and arrangements are being made to collect sufficient data this hot weather to enable the publication of a Volume and Yield Table for blue-pine. As regards teak, (*Tectona grandis*), a large number of sample plots of all qualities up to 60 years old are available, but the Volume or Yield Tables cannot yet be drawn up for want of data of the older age classes.

In the summer of 1925, two Central Institute parties measured 950 trees, mostly *chir* and *deodar*, in Chakrata Division. The volumes, both standard and commercial, of these trees and their outturn were recorded, and the figures thus obtained were used in the compilation of the *Chir* and *Deodar* Volume Tables.

In the cold weather 1925-26 two field parties working in Jalpaiguri and Buxa Divisions of Bengal measured up 400 trees of *Shorea robusta* and about 240 of *Acacia Catechu.* The data collected will be worked up in the coming rains, and local volume tables for the two species will be issued if the data are found adequate to give reasonable reliability.

Various volume data locally collected in Bihar and Orissa, the Central Provinces and the United Provinces were also sent to the Institute for calculation and this was done by the computing staff.

(*iv*) *Bark Measurements, Heartwood Measurements, etc., etc.*

The tables of 29 species giving the deduction to be made from logs measured over bark to obtain the volume of the logs without bark, were published as Forest Bulletin No. 65 during the year. Heartwood measurements of *Acacia Catechu* were made in Jalpaiguri and Buxa Divisions and the volumes of a number of similar measurements of the same species, made by the Bihar and Orissa Research Officer, were calculated here.

(*v*) *Miscellaneous.*

Data for calculation of factors for converting girths and quarter girth volumes into diameter and $\pi\gamma^2$ volumes respectively, were collected and worked up for *Pinus excelsa.* The factors are 0·3133 and 1·2335. The *deodar* conversion factors already published have been revised and are now accepted at 0·3136 and 1·2358. The girths and corresponding diameters of a very large number of blue-pine and *deodar* trees of all sizes and on various slopes were measured last year in Simla and Bashahr with the new German callipers, and were used for deducing the above conversion factors.

The sample plot and single tree volume records have now all been properly indexed and filed under their respective species. Statistical data in one form or another are now available for some 135 Indian species.

III.—MISCELLANEOUS.

The photographic branch has been given more attention during the year. A building hitherto used as an Entomological laboratory has been refitted as a dark room with vastly improved facilities over the old cramped and totally inadequate quarters; the transfer was effected just at the end of the year.

The print collection has been overhauled and divided up, those prints which concern the Economist, Entomologist or Botanist only, having been handed over to them. The silvicultural photographs, which form by far the larger part, and a certain number of photographs of general and miscellaneous subjects, remain. The silvicultural collection has been completely rearranged to facilitate reference. The classification is now specific like all the rest of the records of the branch, and the photos under each species are arranged first by subjects and then by provinces and divisions. All prints are being prepared of standard full plate size (10″ × 8″) and mounted on file-size cards for filing in vertical cabinets. This collection now comprises 3,123 photographs.

The post of Silviculturist was held by Mr. S. H. Howard, Deputy Conservator of Forests, United Provinces, till the end of December and for the rest of the year by Mr. H. G. Champion, Deputy Conservator of Forests, United Provinces. Lala Parmanand Suri remained on deputation from the Punjab throughout the year. Bhai Gurdit Singh, Upper Grade Assistant, worked in the branch till November 1925.

The Silviculturist toured in Assam and Bengal and the staff in the Punjab, United Provinces and Bengal.

BURMA.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Experimental Plots.—There are now 68 experimental plots most of which are concerned with the natural regeneration of *Dipterocarps*.

Comparatively little information has yet been obtained from the plots, but in the more important experiments which deal with natural regeneration several years must elapse before any conclusions can be arrived at.

In the case of the older experiments mainly taken over from territorial divisions, various outside influences have affected the plots and such results as have been obtained are far from conclusive.

It has been impossible for the existing staff to give as much attention to the experiments as they deserve and there is little hope of any improvement in this respect unless an assistant can be provided to take charge of the work in Upper Burma. Unless constant watch is kept on the plots and all work is carried out at the right time much information is lost.

Many more experiments with the natural regeneration of *Dipterocarpus tuberculatus* and *turbinatus*, *Pentacme suavis* and *Shorea obtusa* are required in the Mohnyin, Shwegu, Yinke and Nga-O reserves, and in the mixed dry deciduous forests where artificial regeneration is impossible for one reason or another.

In many of the experimental plots a difficulty has arisen because, in counting and measuring the heights of the seedlings, weeds are pushed aside and trampled down, so that the results obtained in the plots counted over are not representative of the whole area. In most cases, the plots are partly fire-protected and partly burnt and this clearing of the weeds during counting undoubtedly favours the results of fire-protection as the weed growth under fire-protection is in most areas far stronger than where fires take place.

It seems fairly clear that in most of the almost pure *Dipterocarp* forests there would be little or no difficulty in obtaining an adequate stocking by natural regeneration if weedings could be carried out in conjunction with fire-protection. The cost would, however, be prohibitive on a long rotation when 4 per cent. compound interest is added. The timbers are essentially cheap ones and the royalty is bound to remain low.

There are, however, indications that grazing without fire-protection would be successful. In areas near villages where cattle are grazed, the growth of grass is much reduced so that seedlings are able to develop and there is practically no damage from fire. This was particularly noticeable in the Shwegu reserve in Experimental Plot No. 6 (*Pentacme suavis*), and in an area over which improvement fellings had been carried out in the previous year. In the latter area the timber had been cleared leaving only *Pentacme suavis* and *Melanorrhœa usitata*, but, owing to the fact that the surrounding country was flooded for some time, buffaloes had grazed the area heavily during the rains and left it almost free of grass.

In Experimental Plot No. 6 (*Pentacme suavis*), the fire-protected area had been grazed and there were few weeds, and the fire in the burnt area had been very slight, owing to the absence of grass and weeds: little or no damage had been done to the tree crop.

In the case of *Dipterocarpus turbinatus*, fire-protection is essential and grazing is inadvisable as the cattle eat the tender shoots of the young trees and do considerable damage. In the case of this species, however, weeding does not appear to be necessary as it can survive when young under extraordinarily dense cover and will presumably force its way through eventually.

In Experimental Plot No. 1, (Pinwe, Katha Division, Petsut reserve) 5,800 seeds of *Dipterocarpus turbinatus* were sown broadcast in 1922 on 1 acre of ground which had been completely cleared and burnt. In November 1922 there were 524 seedlings and at the latest count—December 1925, three years later—there were still 432 plants of which, 102 were 3′ high, 38 were 5′ and 3 were between 10′ and 15′ high. No weeding had been carried out and the result is excellent, considering that in 1923 and 1924 the area was covered with an almost impenetrable mass of grass and *Eupatorium odoratum.* In 1925, the weed growth was beginning to thin out and it was possible to move about in the area without any very great difficulty.

Buffaloes had entered the area but had done little damage as the seedlings were largely protected by the weeds. As the weed growth dies out under the shade of coppice of woody species the damage from grazing will doubtless increase.

In Experimental Plot No. 2 in the same forest, 5,000 seeds were sown broadcast in very dense *ponzo* (regrowth after clear felling). The area was not burnt and no felling was done. The first count in November 1922 showed a total of 1,332 seedlings of which 939 survive. Growth has not been rapid as only 14 are over 5′ high and 35 over 3′.

In Experimental Plot No. 4, where the low cover was removed and burnt, germination was poor as only 264 seedlings were counted in November 1922. The number has gradually increased and natural seed must have come in. Growth is good as there are now 62 seedlings over 5′ and 163 over 3′ high.

In Experimental Plot No. 5, an area of natural forest with seed-bearers was burnt in 1922 and the seedlings were counted. There has been a nett increase in numbers from 7,000 to 8,000. Mortality has been fairly heavy as nearly 2,000 of the 10,300 seedlings found in February 1925 were dead in December 1925. Growth has been fair as there are now 250 seedlings over 3′ high and three are over 15′ high.

Clearing and burning the natural growth of forest (Experimental Plot No. 6) does not appear to be of any advantage over burning without clearing, as the number of seedlings is far smaller: mortality is higher and growth rather poorer. The reason is probably a dense regrowth from the undergrowth cut back.

All the plots are fire-protected. These experiments are of considerable interest and should yield definite results in another three or four years' time.

Another interesting experiment with *Dipterocarpus turbinatus* is No. 2, Auktaw reserve.

The plot was started in January 1923 on an area of 1·04 acres in all with little undergrowth but with a fairly dense overwood. There was a very good seed year in 1922 and a total of 30,800 seedlings were counted.

The plot was divided into two parts—A, 0·64 acres, containing 18,135 seedlings, and B, where the overwood is rather denser, 0·4 acres, containing 12,716 seedlings. In January 1924, the number had been reduced to 16,000 and 10,000 respectively but by February 1925 as the result of another good seed year the numbers had increased to 23,000 and 16,000 respectively. By December 1925 the number had again fallen to 18,000 and 12,000 but the ground could hardly carry more. Growth is very slow as there are only 640 over 2′ high.

A further object of the plot was the study of the behaviour of the seedlings under various degrees of exposure to light. The plot is unfortunately rather small but A has now been divided into two plots of 0·32 acres each. On half the area the whole overwood has been removed, and on the remaining half the canopy has been opened out. Plot B has been left as it was.

The latest countings have yielded rather interesting information on the distribution of seedlings which is perhaps worth recording though the area is very small.

The Plot A is 200′ long from east to west and was divided in half, so that the small plots are about 100 feet long. From north to south it is 140′ and this was also divided so that countings took place in four quarters, each 100′ × 70′, North-East, South-East, North-West and South-West.

North-East	. 1 seedbearer (on the west edge) no outside seedbearers.	3,215	seedlings.
South-East	. No seedbearers . . .	1,860	„
North-West	. 5 seedbearers, 3 seedbearers just outside.	7,697	„
South-West	. 3 seedbearers, 2 seedbearers just outside.	5,494	„

Considering the smallness of the area the variation in numbers is remarkable, and shows that the seed is only distributed over a very small radius even when the seedbearers are to the west, from which point the wind more often comes.

The ground rises to the west and presumably distribution would be better under reverse conditions but in work on a large scale the question would require consideration. Possibly opening the canopy over a large area would improve the distribution as the effect of the wind would be greater.

A similar case occurred with *Pentacme suavis* in the Shwegu reserve—in this case on flat ground surrounded by fairly open forest—in Experimental Plot No. 10. The total area of the plot, which is in two parts, is 5½ acres and between the parts is a sample plot (of the same origin but weeded from the beginning) of about ½ acre so that the total area is only 6 acres.

Each of the two parts was divided into 4 quarters and the results of counting are as follows:—

A	1	0·56 acres	599 seedlings.	B	1.	0·8 acres	6,657 seedlings.
	2.	0.56 ,,	341 ,,		2.	0·8 ,,	2,118 ,,
	3.	0·55 ,,	841 ,,		3.	0·8 ,,	4,537 ,,
	4.	0·55 ,,	123 ,,		4.	0·8 ,,	4,559 ,,

From this it would seem that even stocking under natural regeneration will be difficult to obtain. In both cases the areas were selected for use owing to the abundance of seedlings, and seedbearers were present. The variation is from 220 to 8,320 per acre.

Plot No. 6, Thazi, Shwegu reserve, Bhamo Division, was laid out in January 1925 to study the effect of clear felling over natural regeneration of *Pentacme suavis*. One plot is burnt and one fire protected.

Month.		Protected Plot.	Burnt Plot.
January 1925	No. of seedlings	591	388
	No. over 5′ high	24	23
	Average height of seedlings over 2′-0″ .	3·4′	3·6′
December 1925	No. of seedlings	637	432
	No. over 5′ high	198	172
	Average height of seedlings over 2′-0″ .	4·6′	5·2′

The plots counted over are 1 square chain each, and the stocking in them is good, though over the whole area it is not so satisfactory.

Growth has been rapid, and, if anything, the burnt plot appears to be the better. As mentioned above the effect of fire and weeds has been very largely reduced by grazing, which probably has had a great deal to do with the satisfactory state of the regeneration.

Plot No. 10. Hnokcho, Shwegu reserve, Bhamo Division, was laid out to compare the results of fire-protection and burning on regeneration of *Pentacme suavis.*

The plot was first enumerated in 1918, but really dates from 1924, as in previous years fire protection failed twice, and no countings were made in 1923. Part of the plot which had been weeded from the start was converted into a sample plot as the trees which date from 1916 had reached an average height of about 17′ and a girth of 9″.

In the burnt plot there is a considerable increase of seedlings following seed years of 1919 and 1921, but in the protected plot, in spite of the fact that it was burnt in April 1919 before the seed fell, there was a decrease in the number of seedlings—possibly those in existence were killed by the fire owing to the accumulation of inflammable material due to previous protection. After the seed year of 1921 the protected plot showed an increase in the number of seedlings; no fire took place. There was another fire in 1922, and no count was made in 1923, but by 1924 the figures were down again to those of 1921, whereas in the burnt plot the increase continued.

The figures were as follows:—

Plot.	1918	1919	1920	1921	1922	1923	1924	Seed-bearers.
1	2	3	4	5	6	7	8	9
Protected Plot . .	4,272	4,565	4,530	4,194	7,555	..	4,194	65
Burnt Plot . . .	3,145	5,800	7,100	6,708	13,000	..	16,113	42

Even making allowance for the possible damage to the seedlings by hot fires in 1919 and 1922, there seems little doubt that regeneration of *Pentacme suavis* is better without fire-protection. Even were the opposite the case, fire protection would not be justified, as results with burning are perfectly satisfactory, and there is no risk of fires occurring in accumulated rubbish which may kill off some of the seedlings.

In 1924 the plot was rearranged and since then the increase has been 3·1 per cent. in the protected and 9·8 per cent. in the unprotected plot.

It is not at present possible to give any details as regards growth, but it has been slow, considering that the plot has been under observation for 8 years. Nearly all the plants are still under 3′ 0″ in height.

As showing the effect of weedings it is of interest to note that part of the plot between the two halves was sown with *Pentacme suavis* in 1916. This area was cleared each year as a fire line and at 9 years old the plants which were burnt were 17′ high and 9″ in girth.

Experimental Plot No. 6, Yinke reserve, Katha Division, was started in 1923 to study the effect of clear felling in the existing regeneration of *Dipterocarpus tuberculatus* with and without fire-protection.

So far it appears that the rapid establishment of the larger seedlings and saplings 5′ and over is assisted by fire-protection, but the smaller seedlings grow extremely slowly, though they have continued to exist.

In the burnt plot the first fire (1924) was a poor one and the second (1925) very fierce. In each year there has been a decrease in numbers in all classes except 10′ and over.

The increase in this class would have been greater had not many of the larger plants been partly burnt back.

Weed growth in the protected plot is very dense and results are probably better than they would otherwise have been owing to the pushing aside and treading down of weeds during the counting of the seedlings.

Strip fellings in *Dipterocarpus tuberculatus* forest (Experimental Plot No. 7, Yinke reserve, Katha Division) indicate that the more nearly they approach clear felling (*i.e.*, the wider they are) the better the results.

Height growth of the larger seedlings and saplings is more rapid under fire-protection, but the number of plants has decreased in all cases. In the burnt plots the number of seedlings has increased in all cases but the plants are burnt back and do not put on a rapid growth in height.

Where stocking is inadequate fire-protection is harmful at the start but is required to establish the crop once it is on the ground.

Plot No. 9. Yinke reserve, Katha Division, shows that, in forest which is comparatively free of grass, improvement fellings have a beneficial effect on the regeneration of *Pentacme suavis* and that there is a slight advantage when fire-protection is carried out. This result apparently contradicts results obtained in Experimental Plot No. 10, Shwegu reserve, mentioned above but in Experimental Plot No. 10, the weed growth is very strong and fire-protection benefits the grass at the expense of the regeneration. Everything points to the necessity for weedings but as these cannot be carried out it is probably best to allow the forest to burn. In the case of *Dipterocarpus tuberculatus*, however, fire-protection is beneficial if the stock on the ground is adequate.

In the North Toungoo Division, Yetkanzin reserve a plot was made in a plantation of 1924 of *Gmelina arborea* (*yemane*) over *Xylia dolabriformis* 6′ × 6′. The former had grown very rapidly and the canopy was almost complete. The experiment was designed to study the effect of the shade of *Gmelina arborea* on the weeds and on the *Xylia dolabriformis.* Unfortunately owing to a misunderstanding no plot was laid out to test the effect of pruning and of removing the shade trees.

The experiment is, however, of interest as showing the results under the canopy of *Gmelina arborea.*

The plot was divided into three parts, heavily weeded and lightly weeded—once only in June in each case—and unweeded. The growth of the *Xylia dolabriformis* (*pyinkado*) has been very slow and the increase in height averages 3·8″, 3·4″ and 2·9″ respectively. This shows that even with the shade of the *Gmelina arborea* (*yemane*) weeding is still necessary for the best results. Though no comparison with the growth of unshaded and weeded *Xylia dolabriformis* is possible, yet it is fairly safe to assert that its growth has been considerably reduced. The question, however, is whether it will eventually grow under shade to such an extent as to be free from weeds and thus become established practically without weeding. If so the *Gmelina arborea* can be easily removed and costs will be reduced considerably provided the growth under shade is sufficiently rapid.

In the North Toungoo Division, Yetkanzin reserve an experiment was carried out with sowing and planting *Dipterocarpus alatus, turbinatus* and closely allied varieties which, if at all different, can at present only be distinguished by their vernacular names.

The seed was sown in an ordinary *taungya* plantation of 1925 and in one case plants were moved with a ball of earth from a nursery.

The following statement shows the number alive on April 4th, 1926:—

Vernacular names.	Number sown or planted.	Number alive on 4-4-1926.	Number dead.	Percentage of survivals.
1	2	3	4	5
Kanyinwetgyi	113	89	24	78
Kanyin-ni-ywet-the	341	138	203	40
Kanyinwettaw	344	294	50	85
Kanyinwettaung planted . . .	342	281	61	82
Kanyinbyu (*Dipterocarpus alatus*). .	40	31	9	77

It is possible that further casualties took place during April but with one exception the percentage of survival is greater than would be expected.

(*ii*) *Natural Regeneration.*

The results of fire-protection in the Kangyi reserve, Zigon Division, which is worked on the selection system, are very marked in the case of *Xylia dolabriformis* (*pyinkado*). There is a considerable quantity of regeneration of this species and although the number of seedbearers is comparatively small the regeneration is well distributed.

No results have yet been obtained as regards the natural regeneration of the dry forest in the Shwebo Division though several experimental plots have been laid out. In one area where heavy fellings had been carried out including the cutting of the bamboo (*Dendrocalamus strictus*) profuse natural regeneration of *Xylia dolabriformis* was noticed but as a general rule the soil is so hard and bare that there is no proper seed bed to receive the seed which falls. The general absence of regeneration may be put down to this fact combined with precarious rainfall and fires in the dry weather.

Fire-protection would almost certainly improve the chances of regeneration by the preservation of the fallen leaves which would protect and improve the soil and retain moisture during a break in the rains, but the rate of growth of the trees is slow and it is doubtful whether on a basis of 4 per cent. compound interest the return on a long rotation would repay the costs. The forest is very dry and fire-protection would be difficult and expensive.

(*iii*) *Seeds.*

Arrangements for the collection and distribution of seed were again carried out. Large quantities of teak seed were sent to India.

The seed year for *Xylia dolabriformis* was very poor and great difficulty was experienced in the collection of the seed of this species.

(*iv*) *Nursery Work.*

It has been found that *Chickrassia tabularis* (*yinma*) seedlings are severely checked by transplanting.

Seeds of paper mulberry, (*Broussonetia papyrifera*), sown at the end of July and again early in August did not germinate at all but those put down in September germinated profusely in seed beds but broadcasting on hoed ground proved a complete failure.

The Swa Nursery.

Nursery work was carried out at Swa in the North Toungoo Division.

The nursery has for the present been closed down as its supervision is difficult.

Various species were tested with and without weeding, and with and without watering from June to January: it was previously intended to test the effect of fire on the beds but it was found impossible to carry this out in such a manner as to imitate natural conditions.

Weedings also have had very little effect because the seed beds were dug up and carefully prepared so that the seedlings only had to contend with weeds which came in by seed instead of weeds already in the ground.

Shorea obtusa (*thitya*).

Stumps obtained from 1 year seedlings were planted out early in June in nursery lines. Mortality was about 15 per cent. by the end of January in spite of weeding and watering and the plants only reached an average height of 4″ in 8 months. One year old seedlings transplanted with a ball of earth did better as they reached an average height of 8″ or 9″. Mortality which mainly occurred in the first fortnight was about 11 per cent.

Some seedlings (107) were left in the seed bed for a second year. Mortality was about 3½ per cent. but the average height increment was only 0·2″. No explanation of this is available. The beds were weeded and watered.

Cassia Fistula (*ngu*).

Eight beds were sown with freshly collected seed; half the seed was placed in boiling water for about 5 minutes (but not actually boiled) and nearly 15 per cent. survived this treatment and germinated as against 57 per cent. of the untreated seed.

The seed was sown in the first half of June and germination continued up to the first half of September.

Some of the beds were weeded, some watered, some weeded and watered, and in some no work was done. The seedlings from treated seeds were small and the details below refer to untreated seed.

	Average height after 6 months.	Percentage of survivals.
Weeded and watered . . .	5·7″	47·7
Watered only	6·1″	54·6
Weeded only	5·8″	64·7
No work	5·8″	48·1

The mortality in one of the weeded and watered beds was 66 per cent. and in the other only 40 per cent. and it is probable that some outside influence affected the former.

Pterocarpus macrocarpus (*padauk*).

Seed of the year collected in 1925 was sown in 2 beds and only 8½ per cent. germinated as against 76 per cent. in the case of seed collected in the previous year. It appears either that the seed of 1925 was of poor quality or that, as has been previously reported, one year old seed germinates more freely than fresh seed. The results of watering and weeding are shown below:—

	Average height after 6 months.	Percentage of survivals.
Weeded and watered . .	12·2″	79·7
Watered only	18·6″	73·5
Weeded only	23·5″	75·8
No work	19·5″	65·5

It appears that watering makes very little difference at any rate up to the end of January when growth was still taking place. The percentage of survival is greatest under weeding and watering but there were very few plants in these beds as compared with the others. Weeding only appears to give the best results probably because the surface of the soil is kept broken by the removal of the weeds.

Experiments in transplanting seedlings of the year with a ball of earth were also tried, the plants being kept watered. The results show that the earlier in the rains the transplanting is carried out the better the growth.

Dipterocarpus tuberculatus (in).

Seeds were sown on hoed ground and it was found that only about 20 per cent. were fertile. Germinating seeds were moved to the seed beds and height measurements were recorded from June to January inclusive. As in the other experiments some of the beds were weeded and watered. The average height at the end of January was roughly 5″ no plants being over 9″ high. Beds which were watered showed a very slightly better growth than those not watered: the percentage of survivals in the watered beds was 80 as against 70 in those not watered.

(v) *Artificial Regeneration.*

The transplanting of various species of *Eucalyptus* from bamboo tubes was continued in the Maymyo reserve with very fair success but much damage was done by crickets, mole crickets and white ants and the results of experiments were thereby spoiled. The crickets bite off the tops of the shoots, the mole crickets bite the stem off at the ground level and the white ants consume the entire root systems. The experimental area was sited in an old *taungya* where regeneration had failed and the damage was far worse here than in the newly cleared area planted up during the year.

Stumps were tried and at first appeared to be very successful: even large stumps up to 1½″ in diameter produced shoots. Later the shoots all withered and died off but at the close of the year new and strong shoots were produced and there are still hopes that this method will eventually be successful. Mortality is small but white ants have been found attacking a few of the stumps.

The following statement of the rate of growth of various species may be of interest. All were in plantations unless a note to the contrary is made:—

Species.	Vernacular name.	Division.	Age.	Height.	Girth.	REMARKS.
1	2	3	4	5	6	7
Tectona grandis	Teak	Insein	4	27′	1′ 0″	Dry and shallow soil.
Xylia dolabriformis.	*Pyinkado*	,,	4	10—15′	..	
Terminalia tomentosa	*Taukkyan*	Tharrawaddy	5	27′	1′ 5″	Swampy ground Thindawyo reserve.
Eriolæna Candollei.	*Dwani*	,,	4	25′	1′ 1″	
Terminalia Chebula	*Hpanga*	,,	4	14′	..	

Species.	Vernacular name.	Division.	Age.	Height.	Girth.	REMARKS.
1	2	3	4	5	6	7
Lagerstroemia Flos-Reginæ.	*Pyinma*	Tharrawaddy	4	10′ (average)	..	Some producing seed.
Anthocephalus Cadamba.	*Mauletlanshe*	,,	20	60′	4′ 0″	Natural forest tree felled.
Bambusa polymorpha	*Kyathaungwa*	,,	Clumps probably 50 to 60 years old.	85′	1′ 4″	
Pterocarpus dalbergioides.	Andaman *padauk.*	Zigon	18	81′	4′ 0″	
		,,	8	51′	2′10″	
		,,	5	36′	1′ 5″	
		,,	4	32′	1′ 0″	
		,,	7	45′	1′ 8″	
		,,	5	30′	..	Coppiced at 4 years old. Several shoots.
		,,	30	76′	3′ 1″	
Albizzia procera	*Sit*	,,	7	42′	1′ 8″	
		,,	6	39′	2′ 1″	
Lagerstrœmia hypoleuca.	Andaman *pyinma.*	,,	7	32′	1′ 0″	
Vridelia retusa	*Seikchi*	,,	2	up to 8′	..	
Eriolæna Candollei.	*Dwani*	Prome	2	11′	..	
Albizzia odoratissima	*Thitpyu*	,,	2	10′	..	
		,,	1	10′	..	2 years' plants coppiced.
Xylia dolabriformis.	*Pyinkado*	,,	3	7′	..	

(vii) *Thinnings and Cleanings.*

From the inspection of the more recent thinnings in young teak plantations it is clear that early and heavy thinnings are very beneficial.

There is unfortunately evidence that trees in older plantations which have formed a definite crown and have not been thinned out heavily are unable to respond to treatment at least for several years. It is difficult to account for this but it is known that the buds of teak trees early in the rains are extremely tender and it is possible that constant injury caused by the trees being blown against one another may have produced so much callus growth that no strong shoots can be put out.

Whatever the cause it is clear that past methods have not been a success and that the remedy is to thin teak plantations from very early years in such a way that the crowns are kept in a vigorous and healthy condition.

Observations show that teak plantations are healthiest where there is an undergrowth. As no undergrowth can survive under a dense stock of teak this may only be the result of the wide spacing mentioned above, but there are definitely other advantages in encouraging the undergrowth, the chief of which is the protection of the soil from erosion, due to the drip from the teak leaves in the rains, and to the absence of any cover of leaves to check the flow of water over the surface unless the plantations are protected from fire. Heavier thinning than has been carried out in the past is again clearly indicated.

Sometime must elapse before definite figures of the rate of growth of teak trees under various types of thinnings will be available but meanwhile observation shows that the heavier thinnings give the best results and that early thinnings are essential.

There is, however, one point as regards early thinnings which must not be overlooked. In plantations where there is much grass it is essential to keep the canopy closed until it has been killed out. The growth of teak in such places is poor and so long as the grass remains so long will growth be retarded.

Cutch (*Acacia Catechu*) is another species which requires early and heavy thinnings.

Little is known about the spacing required by *pyinkado* (*Xylia dolabriformis*) but the lower branches appear to persist in spite of dense shade for several years.

Measurements of the crown-spread of healthy and vigorous trees showed that at about 70′ high and 3′ 0″ in girth (probably about the age of 20 to 25) a spacing of 19′ between the trees was ample. A spacing of 13′ or 14′ was too close and 21′ unnecessarily wide.

(*viii*) *and* (*ix*) *Mixtures and Underplanting.*

In view of the great importance of an underwood in teak plantations experiments are required to test the possibility of introducing shade bearing species of slow growth under teak.

In the Insein Division experiments have been made on a small scale with *pyinkado* (*Xylia dolabriformis*) under fairly heavily thinned out teak. So far its growth has been disappointing. Experiments are now being made with other species, specially those suitable for fuel.

Heavy thinnings combined with fire-protection will probably be sufficient in most forests to ensure the introduction of the natural mixed underwood.

(*x*) *Silvicultural Systems.*

No work on these lines has been carried out but in the Magayi reserve, Insein Division, it is evident that natural regeneration under the selection system would suit *myaukchaw* (*Homalium tomentosum*) but the value of this species lies in the fact that it is excellent fuel and consequently clear felling would be more appropriate. The tree has little or no value at any distance from Rangoon.

II.—WORKING PLANS AND STATISTICS.

(*ii*) *Yield Tables.*

During the year 41 new sample plots were formed of which 29 were formed to study the volume increment per acre of *Tectona grandis*, teak. A larger number could have been formed but special efforts were made to obtain plots in various quality classes and to fill gaps in age classes. This necessitated the examination of large numbers of plantations.

There are now a total of 236 sample plots of which 166 are teak, 21 *Dipterocarpus tuberculatus* (*in*), 12 for *Pentacme suavis* (*ingyin*).

There is only one plot of *Xylia dolabriformis* (*pyinkado*) at present but it is hoped to form further plots shortly as some of the older plantations will soon contain trees large enough for the purpose.

BOMBAY.

General.

A research branch was started during the year under the immediate control of the Chief Conservator, and enquiries into the following 20 subjects were commenced:—

1. Investigation into the reasons for variations in the results of teak regeneration work.
2. Germination tests of teak seeds.
3. Comparative results in teak plantations of
    - (*a*) dibbling of seed;
    - (*b*) use of seedlings of a few weeks old;
    - (*c*) use of one-year old transplants.

4. Effect of thinning of teak coppice of different ages.
5. Effect of different degrees of thinning in teak plantations of different ages; and of under-planting with shade-bearers.
6. Effects of (1) reduction and (2) abolition of watering in *Casuarina* plantations.
7. Annual girth increment of *sandal.*
8. Increment of *babul* (*Acacia arabica*) under different degrees of thinning.
9. Propagation of lac on *ber* (*Zizyphus Jujuba*).
10. Economic age for cutting *bahan* (*Populus euphratica*) coppice and degree of thinning required.
11. "Stoning" of teak seedlings as a protection against animals and an aid to their growth.
12. Artificial propagation of *rosha* (*Cymbopogon Martini*) grass.
13. Propagation of *hirda* (*Terminalia Chebula*).
14. Propagation of bamboos.
15. Relative value of different species for making charcoal.
16. Effect of improvement fellings on diameter growth.
17. Effect of cutting back superfluous shoots of two-year old teak seedlings.
18. Investigation into the effect of shade on *lantana* (*Lantana Camara*).
19. Coppicing of *anjan* (*Hardwickia binata*).
20. Preservation of natural *anjan* seedlings.

A further report will be sent in next year.

MADRAS.

1.—Experimental Silviculture.

(*i*) *General.*

From the experiments carried out last year and during previous years, the following tentative results (positive and negative) are given. Deductions can, of course, only be made with certainty after a considerable number of years.

(*a*) *Dalbergia latifolia.*—At Nilambur this species requires a certain amount of shade when very young. The broken shade which is left when all marketable trees are felled and removed from a deciduous forest of good quality seems to be just what is required, (Nilambur Plot No. 19). The growth of the seedlings is fairly rapid in the second year.

(*b*) *Hopea parviflora.*—To obtain natural regeneration, weeding is required (South Mangalore Plots 13 and 14). When being introduced as an underwood to teak in Nilambur Division this species during the hot weather requires the protection afforded by the shade of a *heavy* undergrowth, as the teak casts almost no shade (Nilambur Plots Nos. 6 and 21). Planting two plants at each stake has, on the whole, given rather better results than planting one plant per stake. Covering plants with fallen teak leaves during the hot weather has not produced good results.

(*c*) *Terminalia paniculata.*—It has not been found possible yet to obtain even fair germination of seed.

(*d*) *Mesua ferrea.*—Only very poor germination of seed has been obtained.

(*e*) *Artocarpus hirsuta* and *Artocarpus integrifolia.*—When being planted as an underwood to teak in Nilambur Division these species die off in the hot weather where the existing undergrowth is only moderate (Nilambur Plots Nos. 22 and 23).

(*f*) *Lagerstroemia lanceolata* and *Lagerstroemia Flos-Reginae.*—Both these species do well at Nilambur when planted in broken shade (Nilambur Plot No. 19). The latter is, of course, suitable for swampy areas. It has been tried before in the open in an area liable to get swampy and has failed. The former was planted in an area unsuited to teak.

(*g*) *Terminalia tomentosa.*—Poor results have been obtained with this species at Nilambur. The system used at Mount Stuart gives good results there. Dumps are formed (*i.e.*, a bag of seed is upset on to the ground, which is not prepared in any way) and allowed to germinate. The germinating seed is then planted out.

(*h*) *Natural Regeneration of Evergreen Species* (except *Hopea*) —Only negative results have been obtained so far.

In addition to the plots dealing with different methods of regeneration under maintenance by the Forest Research Officer ten plots were opened in Karian Shola (South Coimbatore Division) to promote natural regeneration of evergreen species where it was deficient.

Three plots were taken over from the Nilambur District early in 1925 and two plots were opened by the Forest Research Officer during the year for the purpose of under-planting teak with different species at Nilambur.

For the purpose of finding out girth increment of *Acacia Catechu* three sample plots were laid out by the North Mangalore Division. These were taken over by the Forest Research Officer after enumeration.

Two new plots were opened in Palghat Division to find out how *Acrocarpus fraxinifolius* responded to silvicultural operations and also to find the total cost.

Singampathy Coupe I, Bolampatti Range, Palghat, was taken over by the Forest Research Officer for experiments to be carried out in 1926.

(*ii*) *Natural Regeneration.*

The plots in Nalkur (South Mangalore Plots Nos. 6 to 10) laid out for investigating the best method of uncovering young *Hopea* in an evergreen forest (five half-acre plots) were last enumerated in June 1926 and the results are compared below with those of last year.

Plot No. and particulars.	Sample patch No.	1925				1926			
		Total No. of seedlings.	Number of those which are over 3 feet in height.	Average height of 6 tallest.	Height increment of 6 tallest during the year.	Total No. of seedlings.	Number of those which are over 3 feet in height.	Average height of 6 tallest.	Height increment of 6 tallest during the year.
Plot No. 6 (only weeds and undergrowth removed).	I	219	48	7′4″	4″	151	45	7′ 8″	4″
	II	307	..	2′ 3½″	4½″	237	1	2′ 7″	2½″
Plot No. 7 (control plot: nothing done).	I	225	33	6′ 5″	5″	188	21	6′ 9″	4″
	II	334	2	3′ 7″	3″	390	3	4′ 1″	6″
Plot No. 8 (weeds and trees of upper storey cut).	I	321	65	9′	1′ 8½″	445	15	10′ 5″	1′ 5″
	II	334	9	4′ 9½″	8½″	204	73	5′ 1″	3½″
Plot No. 9 (weeds, undergrowth and middle storey removed).	I	456	13	4′	8½″	266	30	4′ 7″	7″
	II	36	3	3′ 4½″	5½″	35	9	4′ 4″	11½″
Plot No. 10 (everything except *Hopea* cut and removed).	I	127	18	5′ 4½″	10½″	79	16	7′ 1″	1′ 8½″
	II	154	42	10′ 5½″	1′ 3½″	77	46	11′ 11″	1′ 6½″

There have been very heavy casualties in Plots 6, 9 and 10. The height growth cannot be considered rapid even in the open. This is possibly because much of the regeneration in existence when the plots were opened was probably stunted advance growth of considerable age instead of being young plants, as was supposed.

The experiment which was conducted to note the percentage of young *Hopea* seedlings which survive in an area where there has been profuse regeneration (Plot No. 35, Palghat, Chenath Nair Reserve) gave at the end of March 1926, 72 per cent. success.

The following is the result of enumerations in Plot No. 41, Palghat (Chenath Nair R.F.) laid out to stimulate natural regeneration and the development of seedlings of the more valuable evergreen species by cutting weeds and undergrowth.

—	1ST HALF, RAKED, AREA 2½ ACRES.					2ND HALF, UNRAKED, AREA 2½ ACRES.				
	0—2′.	2—4′.	4—6′.	Over 6′.	TOTAL.	0—2′.	2—4′.	4—6′.	Over 6′.	TOTAL.
In September 1924.										
Calophyllum .	69	13	11	25	118	44	21	7	12	84
Mesua ferrea .	44	15	5	17	81	37	22	7	12	78
Dichopsis . .	18	..	1	7	26	6	..	..	1	7
Hopea . . .	1	..	..	..	1	..	..	..	..	..
TOTAL .	132	28	17	49	226	87	43	14	25	169
In September 1925.										
Calophyllum .	174	21	18	29	242	169	34	11	14	228
Mesua ferrea .	53	21	8	17	99	48	38	8	14	108
Dichopsis . .	44	2	6	7	59	15	..	..	2	17
Hopea . . .	..	1	..	..	1	..	..	..	..	..
TOTAL .	271	45	32	53	401	232	72	19	30	353

In the Control Plot (where nothing was done) the total number of seedlings on one acre increased from 183 to 282.

With a view to promote natural regeneration where such regeneration was deficient the following plots were laid out during the year in South Coimbatore Division (Karian Shola):—

> Seven plots of 4 acres each, one plot of 2 acres, and two of one acre each. The density of the regeneration is being estimated by eye, full stocking being taken as 3′ × 3′. So far there has been no appreciable difference, but it is hoped that there will be something to record in the next report.

(*iii*) *Seeds.*

Great difficulty has been found in raising *Mesua* and *Calophyllum* seedlings in a nursery. A bag of *Mesua* seed produced seventeen seedlings. *Calophyllum* germinated moderately well, but the seedlings died after a few weeks. In both cases the beds were shaded and watered daily.

(iv) *Nursery Work.*

The nursery at Sappal was abandoned during the year and the rest (one at Nilambur and the other at Nedungayam) were maintained for raising seedlings for transplants.

A small nursery experiment was carried out at Nilambur to find out the effect of shading and watering on *Hopea* seedlings during the dry season. Plants both shaded and watered did best. Shading alone was more beneficial than watering alone.

(v) *Artificial Regeneration.*

The following plots are maintained for conversion of deciduous forest into an evergreen one.

Nilambur Plot No. 12.—Mangifera indica dibbled.—In June 1925 there were 27 per cent. survivals. The casualties were replaced. In March 1926 there were 47 per cent. survivals, one and two years old. At the end of May 1926 there were only 25 per cent. survivals.

Nilambur Plot No. 13.—Hopea parviflora transplants under natural forest of *Xylia xylocarpa.* An enumeration in March 1926 gave the following survivals. Planted at stakes 82 per cent. survivals, all one year old. Planted in pits 79 per cent. survivals of which only 11 seedlings were two years old. At the end of May 1926 the survivals were:—

Planted at stakes	51 per cent.
Planted in pits	51 per cent.

This plot suffers from insufficient shade.

Nilambur Plot No. 14.—Hopea parviflora sown under natural forest of *Xylia.* Enumerations in June 1925 gave 37 per cent. at stakes and 25 per cent. in pits. The casualties were replaced. The plants looked healthy in September 1925. In March 1926 there were 35 per cent. two-year old plants surviving at stakes and a total percentage of survivals of 86. In pits there were 20 per cent. two-year old plants surviving and a total number of 80 per cent. At the end of May 1926 the survivals were:—

Planted at stakes	63 per cent.
Planted in pits	61 per cent.

The shade is heavier than in Plot No. 13, and the area sown in pits is under lighter shade than the area sown at stakes.

Nilambur Plot No. 15.—*Mangifera indica* transplanted under natural forest of *Xylia.* Casualties were replaced after the enumeration in June 1925.

Survivals :—

	June 1925.	March 1926.	May 1926.
Planted at stakes .	37 per cent.	78 per cent.	60 per cent.
„ in pits .	41 „	80 „	59 „

Nilambur Plot No. 19.—When this plot was formed, all saleable trees were felled and removed. The remainder were left standing. A light fire was run through the area in order to clear the ground. This plot was intended to discover what species were suitable for felled areas, which are too swampy or badly drained for teak, and gave the following result when inspected in June 1925.

Dalbergia latifolia	49 per cent.
Lagerstroemia Flos-Reginae . . .	89 per cent.
Lagerstroemia lanceolata	9 per cent.
Terminalia tomentosa	11 per cent.

Casualties were replaced according to the seedlings available. In March 1926 the survivals were as follow :—

		In May 1926.
Dalbergia latifolia . . .	79 per cent.	79 per cent.
Lagerstroemia Flos-Reginae .	87 per cent.	...
Lagerstroemia lanceolata .	62 per cent.	70 per cent.
Terminalia tomentosa . .	22 per cent.	22 per cent.

The *Lagerstroemia lanceolata* was leafless in March, and some appeared to be dead when evidently they were not. The *Dalbergia latifolia* area is, most of it, not liable to become swampy. It is disintegrated laterite classed as unfit for teak. The growth of the *Dalbergia* under the broken shade is remarkably good. This area compares very favourably with the adjoining clear felled area in which *Dalbergia* was put in in the open by the District Forest Officer and in which casualties appear to have been very heavy. In Plot No. 19 half the *Dalbergia* area has been fenced. The unfenced half has suffered from browsing to a certain extent.

As per Chief Conservator's Inspection Note on Chenath Nair R.F. in March 1925 all the plots except 35, 36, 37 and 41 (Palghat) were abandoned after recording the percentage of survivals early in 1925.

In September 1925 a small experiment was tried in Chenath Nair Reserve to see if *Acrocarpus fraxinifolius* could be regenerated artificially in a clear-felled area (Palghat Plot No. 42). Two plants per stake were notched. By notching is meant making a hole with a pointed stake, inserting the roots of the plant into the hole and then pressing the sides of the hole together by hand. In March 1926 the survivals were 52 per cent. The cost of the operation works out at the rate of Rs. 6-4-0 per acre. The experiment will be repeated on a larger scale in 1926.

(*vii*) *Thinnings and Cleanings.*

Three small plots of *Hopea parviflora* were laid out at Urti near Makut in Coorg, and thinned to the following espacements:—

$8\frac{1}{2}' \times 8\frac{1}{2}'$; $12' \times 12'$; $16' \times 16'$.

The object is to see how long it will take the canopy to close up. In the plots the *Hopea* is of all sizes up to 6 inches diameter.

(*ix*) *Underplanting.*

Introducing *Hopea* under 8-year old teak (Nilambur Plot No. 6). This plot was started in 1923 and was a failure. It was replanted in 1924. Survivals in June 1925 were:—

Single seedlings planted in pits .	7 per cent.
Two seedlings planted in pits . .	15 per cent.

The casualties were replaced. The seedlings were mulched in December 1925 and January 1926 (half each time), and in January and February 1926 they were covered loosely with dry teak leaves (half each month as per orders of the Inspector General of Forests). The survivals in May 1926 were:—

Single seedlings planted in pits .	18 per cent.
Two seedlings planted per pit .	19 per cent.

In this plot there is very little undergrowth under the teak.

Introducing *Hopea* under 5-year old teak by planting. *Nilambur Plot No. 21.* This plot was started in 1924. In June 1925 the casualties amounted to 87 per cent. where single plants were out in pits, and 74 per cent. where two plants per pit were put in.

The casualties were replaced. The results at the end of March 1926 were as follow:—

Survivals:—

Single pits	64 per cent.
Double pits	78 per cent.

In May 1926 the survivals were 11 per cent. and 20 per cent. respectively. In this plot there is more undergrowth than in Plot No. 6, but there is evidently not enough.

In Aruvacode 1921 teak plantation an experiment was started in 1925 (Nilambur experimental Plot No. 22) to discover whether jack (*Artocarpus integrifolia*) can be introduced as an underwood for teak. Pits 1′ cube were dug between teak lines 6′ apart. Seedlings were raised in bamboo tubes and were transplanted (one in each pit). In May 1926 the percentage of survivals was 31.

A similar experiment with *Artocarpus hirsuta* in Aruvacode 1921-22 plantation (Nilambur experimental Plot No. 23) gave 22 per cent. success at the end of May 1926. The existing undergrowth in both these plots (22 and 23) varies from light to moderate.

(*xi*) *Miscellaneous.*

Plot No. 14 in South Mangalore was laid out in 1920 to note the effect of weeding on natural regeneration of *Hopea*. The plot is weeded. Results of enumerations carried out on 400 square feet are as follow:—

Year.	No. of seedlings.	No. over 3 feet high.
1921	214	...
1922	345	...
1923	182	...
1925	232	8
1926	513	16

Plot No. 13 (South Mangalore) is the control for the above plot. No weeding was done. Similar enumerations are as follow:—

Year.	No. of seedlings.	No. over 3 feet high.
1921	150	...
1923	150	...
1925	116	...
1926	106	2

Nilgiris Experimental Plot No. 1 (Burliar Reserve) which was started for ascertaining whether sandal generated from stumped seedlings will grow faster than when grown from seed or from nursery transplants and if so, what size seedlings should be used for stumping, gave at the end of 1925, 19 per cent. survivals from stumps prepared from plants 2′ to 3′ high and 22 per cent. from those prepared from plants 3′ to 5′ high.

According to Chief Conservator's orders, Compartment 120 of Nilambur Forest Division was taken over by the Forest Research Officer for experiments. A certain amount of felling was done in this Compartment during the year, preparatory to experiments being carried out in 1926.

II.—WORKING PLANS AND STATISTICS.

(ii) *Yield Tables.*

Yield tables have not been drawn out. The following sample plots dealing with volume increment, etc., of the following species are maintained by the Forest Research Officer:—

Species.	No. of plots.	Locality.
Tectona grandis	50	Nilambur.
Ditto	9	Wynaad.
Xylia xylocarpa	2	Nilambur.
Hopea parviflora	6	South Mangalore.
Ditto	3	North Mangalore.
Acacia Catechu	3	Ditto.
Pterocarpus santalinus	1	South Cuddapah.
Hardwickia binata	1	Bellary.
Shorea robusta	10	Ganjam.
TOTAL .	85	

The periodical measurements of the above sample plots are being recorded. No sample plot fell due for measurement during the year (1925-26).

III.—MISCELLANEOUS.

Photographs of different species are kept in an album arranged in the order of the species dealt with.

The Records and Ledger files are kept after the Dehra Dun model.

UNITED PROVINCES.

I.—EXPERIMENTAL SILVICULTURE.

(*i*) *General.*

In continuation of the latest policy in accordance with which experiments are conducted as far as possible by the Divisional Forest Officer in whose division the experiment is located, all divisional officers were provided during the year with complete copies of the experimental files relating to experiments in their divisions.

(*ii*) *Natural Regeneration.*

Sal (*Shorea robusta*).—More attention has been devoted during the past few years to this than to any other silvicultural problem. The problem may be briefly sub-divided into that of obtaining seedling regeneration, that of inducing the regeneration to persist when once obtained, and that of inducing the regeneration steadily to increase in height growth year by year.

The problem of the best method of obtaining seedling regeneration has been practically solved at least for the better types of forest, and controlled burning about the first week in April can probably be relied on to give success within a reasonable short period.

The next problem, that of inducing this regeneration to persist will require study for many years before anything like finality is obtained. Nevertheless considerable progress has already been made.

The experiments at Lakhmanmandi in the Haldwani division which were started in 1921 continue to give useful negative results. In the report for 1923-24 it was stated that a good shelterwood felling in this forest had eliminated dying back. This statement was incorrect, and, though the canopy has been subjected to all grades of thinning including complete removal, there are as yet no signs that any seedlings are even approaching the stage at which they will steadily increase in height. But besides showing that manipulation of the overhead light is in itself insufficient to eliminate the period of dying back, these experiments have also shown the danger of too heavy felling which result in an excessively dense growth of grass, so dense as to cause heavy mortality among the *sal* seedlings. Finally it has also been proved here that if the canopy is left very dense, the *sal* seedlings will disappear. Probably 95 per cent. of the original 1913 seedling crop has already completely disappeared. It is necessary to add that these *sal* forests are of the Bhabar type and that the experiment did not include regular controlled burning. Having disposed of one of the original theories, namely that a proper manipulation of the light was all that was required, we are now proceeding to test the next theory, which is that, in order to induce the seedlings to persist on a large scale in this type of *sal* forest, controlled burning, either annual or periodic, is essential.

The third problem is that of inducing *sal* regeneration not only to persist but to add something to its height growth each successive year. Only recently it was assumed by many forest officers that, with a suitably regulated felling in the overhead canopy, the period of dying back could be considerably curtailed, if not entirely eliminated. Small sample plots for *sal* seedlings laid out in 1913 all over the Province have, however, failed during the last 13 years to produce a single seedling which can be said to have developed a shoot which will steadily progress in height growth. And this, inspite of the fact that many of the plots have been kept carefully weeded whilst others have been hoed up on the surface, and all conditions of light and shade have been represented. There is also an experimental plot at Thano in the Dehra Dun Division laid out by Professor Troup in 1910 with seedlings from that year, but no seedling in this plot has yet begun to put on annual height growth. In consequence of these experimental plots and as a result of general observation it is now believed by many of those who have studied the problem closest in these Provinces that the normal period of dying back under forest conditions is 20—30 years. To what extent, if at all, we shall be able to reduce this natural period is one of the problems before us. As a possible help in reducing this period it is thought that controlled burning may prove to be of value though at present the available evidence tends to show that nothing the Forester can do will materially shorten this time of stagnation. A large number of experiments in controlled burning have, however, been started this year in most *sal*-bearing divisions of the Province. In each case burnt and unburnt areas have been selected for comparison and a detailed system of observations should in a very few years indicate the effect of controlled burning on the reduction of harmful weed growth and the subsequent development of *sal* seedlings.

In considering the problem of the natural regeneration of *sal* we can recognise three stages below that of the sapling, namely—

(1) Small seedlings,

(2) Whippy shoots up to about 2′ high,

(3) Advance growth as thick as a man's finger and 2—4 feet high,

and in the Dehra Dun division, where the regeneration area contains large quantities of all these stages of growth, and in which the present system only differs from clear felling in the retention of a few standards for protection from frost, the following results are obtained by burning the felled areas over in about the third week of March :—

(1) Small seedlings send up shoots which persist but do not develop at all in height growth for many years.

(2) Whippy shoots are intermediate. They again send up strong whippy shoots which usually fail to increase in height growth in subsequent years.

(3) Thicker advance growth sends up a strong shoot which puts on annual height growth and becomes a sapling in a very few years.

In 1913 an experiment in Gorakhpur division was started by Mr. Marriott, with a view to ascertain the best method of obtaining natural regeneration in well stocked *sal* forest of the usual Gorakhpur type on flat localities liable to a certain amount of inundation during the rains, but free from frost. Eight plots of one acre each were laid out near Lachmipur and the experiment was so arranged that the effect of—

(*a*) Opening out the canopy and leaving only 15 seed-bearers per acre,

(*b*) Closing to grazing,

(*c*) Hoeing up the surface once before a good seed year and forming shallow mounds in the process,

could be watched in various combinations. The soil in the experimental area was described as "clayey and hard" before the experiment began and there was then no regeneration to speak of, and only a scanty undergrowth. In 1913 abundance of seed fell and the results of this seedfall were commented on at intervals by various observers up to 1921. After this date the experiment was vitiated by the fact that coppice shoots had not been kept in check and they had grown to such dimensions as to suppress and kill out the *sal* regeneration in plots where the canopy had been opened. The conclusions to be drawn from this experiment are as follow:—

(*a*) Regeneration cannot be successfully obtained under a complete overhead canopy as, in the absence of light, seedlings die after a period of 3—6 years though germination may have been excellent. (*N.B.*—There is of course the possibility of clear felling or a heavy thinning in, say, the second year *after* a good seed year.)

(*b*) Opening out the canopy, wounding the soil, and fencing combined with grass cutting in November and December has produced good results, better than any other combination of operations. Grass cutting, however, seems to be essential whether the area is fenced or not.

(*c*) Regeneration, contrary to expectations, does not succeed on the mounds but on the intervening ground.

(*d*) Wounding the soil greatly increases the percentage of success in germination, especially if rains are delayed when the radicle dries up unless it is brought in direct contact with mineral soil.

This experiment has now been abandoned and it is interesting to speculate on the possibilities of greater success had controlled burning been carried out from 1914 onwards.

An experiment started by Mr. Troup in 1911 in the Gonda division to investigate the effect of coppicing stumps at 6″ from the ground, and flush with the ground has been concluded this year. Two plots were laid out in coppice 20 years old with standards interspersed here and there, as follow:—

Plot No. I.

Cut flush with the ground—

	Stumps.
Sal	181
Other mixed species	89
	270

Plot No. II.

Cut 6″ from the ground—

	Stumps.
Sal	155
Sain (*Terminalia tomentosa*) . . .	5
Other mixed species	196
	356

After 14 years' growth the resulting shoots compared as follow:—

1925.

——	Plot I.	Plot II.	REMARKS.
	Feet.	Feet.	
Average height	33	36	The average height of 20 years old coppice was originally 37 feet.
Average diameter	3·6	4·3	
Number of shoots per stool . .	1·6	1·8	

From this experiment we may conclude that cutting 6″ above the ground is slightly more favourable than cutting level with the ground but that the difference is very small.

Measurements made of the height growth of 10 *sal* shoots in a clear-felled, and 10 in a shelter-wood, area have yielded some interesting results. On the 2nd of April 1921 an area was burnt over clean and the measurements of coppice shoots were commenced from the 2nd of May and continued on the 2nd of every month. The conclusions to be derived from this experiment are:—

(1) That the maximum growth takes place during April, May and June.

(2) That the increment in height growth is least during July.

(3) A further increase in height takes place in either August or September, but it becomes less in October and November, and comes practically to a standstill during the following 3 months.

Three experiments introduced with a view to studying the effects of clear-felling have been brought to a close during the year. One was an area of about 5 acres in compartment 8 near Thano in the

Dehra Dun division. This area was clear-felled in 1919. Another was an area of 24 acres near Dudua in the Kheri division, and the third was an area of 126 acres in the same division near Sarota. These latter two were felled in 1916 leaving a few standards per acre, but the standards were removed two years later. All these three areas were liable to frost damage and the general conclusions for the areas so situated may be stated as follow—

(*a*) That clear-felling, even when there is advance growth on the ground, is not a suitable system of regeneration. A certain number of standards must always be retained.

(*b*) Neither the retention of weeds nor their removal has any material effect in mitigating the damage done by frost whilst the coppice shoots are young, though large shrubs like *Mallotus* do afford some measure of protection.

(*c*) Protection from the morning sun reduces the frost damage and may enable the *sal* to survive, when in neighbouring areas not so protected it is killed back. This was observable along the edge of the Sarota area which was protected from the morning sun by the adjoining unfelled forest.

(*d*) That small areas surrounded by extensive forest should never be regenerated separately in this manner on account of the excessive damage done by deer.

Chir (*Pinus longifolia*).—The protection of the regeneration from fire is one of the chief difficulties in Kumaon at present. Considerable experimental work is being carried on to decide the earliest moment at which a regeneration area can be burnt under proper control and it seems probable that, except in areas where grass is unusually heavy, we shall be able to burn all regeneration as soon as the plants are 2 feet high. This will mean reducing the period of strict fire protection to about 8 years, whereas if fire protection is continued till the poles are safe from casual uncontrolled fires the period will be about 25—30 years. The risk is, therefore, reduced to about one-third.

Khair (*Acacia Catechu*).—There is generally little difficulty in obtaining regeneration of this species by artificial sowings, but the best method of obtaining natural results has not received in the past the attention it deserved. It is, therefore, interesting to note that in the North Kheri division where an area had been fenced in as a plantation and protected from fire and grazing natural regeneration is appearing in a most satisfactory manner.

Silver Fir and Spruce.—An experiment which was started in 1914 by Mr. Troup in the Chakrata division has been concluded this year. Four plots A, B, C and D, each of about 1 acre, were laid out in Deoban Working Circle, at about 8,300 feet elevation, on a northern aspect, with moderate gradient, in a mixed forest of spruce and silver fir, the former predominating. The object of the experiment was to induce natural regeneration on the ground under an overwood of varying density. Plots A and B had been, up till the commencement of this experiment, closed to grazing, and they contained a dense undergrowth of hill bamboo and shrubs, but herbs were less dense.

During the spring of 1915 the undergrowth was cut and the debris burnt in Plots B and D but not in A and C and the fencing of all the areas was completed by October 1915. At this time it was noted that there was little seed on the trees and so no cultivation of the soil was attempted. In October 1916 a good deal of seed seemed about to fall and half of each plot was accordingly hoed up to a depth of 4 to 6 inches and in Plots B and D the undergrowth was again cut back. The result of these operations was to produce a very dense growth of weeds among which *Strobilanthes* was especially noticeable. In the hoed areas the weeds were less formidable but still very dense. As regards reproduction of spruce and silver fir the operations were a complete failure. Scarcely a seedling being visible in October 1917 though the 1916 seed year seems to have been a fair one. The area was again inspected in 1920 and 1924 and at both these inspections it was found that the plots were still without any natural regeneration of spruce and silver fir, and that the ground was covered with dense herbaceous undergrowth which in parts of the area was giving place to *Rubus* species.

The conclusions to be derived from this experiment are that in this type of silver fir and spurce forest it is useless to open out the canopy heavily as the weed growth will successfully prevent all natural regeneration. Observations indicate that a light thinning out of the crop so as to leave stems some 30 feet apart followed by cutting the undergrowth and burning might be successful.

(iii) Seeds.

In the Gonda division two sets of experiments on the best method of preparing teak seed for sowing were carried out. In one set of experiments the seed was treated as follows—

(*a*) Soaked in water and kept in a pit covered with clay for 3 days before sowing.

(*b*) Soaked in water for 48 hours before sowing.

(*c*) Soaked in water for 7 days before sowing.

(*d*) Scorched with a light fire made by spreading ½-inch of leaves above and below the seed.

In this experiment the last two methods gave germination results which were twice as good as the first two methods.

In the other set of experiment the seed was treated as follows:—

(*a*) Soaked in water for 48 hours, then exposed to the sun for 10 days and finally soaked again for 48 hours before sowing.
(*b*) Same as (*a*) but the process repeated once more.
(*c*) Soaked in water for 24 hours, then exposed to the sun for 48 hours; this process being repeated 5 times.
(*d*) Soaked in water for 72 hours before sowing.
(*e*) Placed in pits covered with a layer of earth about 1 foot thick and drenched every third day for 6 weeks.

In this experiment the last method gave nearly twice as good germination results as any of the other methods.

In the Gorakhpur division 100 per cent. germination of teak seed was obtained by sowing the seed broadcast in April and covering it with a 2 inch layer of grass which was then sprinkled with water every third day till the rains broke. It was noticed that white ants had eaten up all the grass by this time and the seed had been covered up by the earth which the termites had brought to the surface. It is not recorded whether the outer coat of the seed had been partially devoured by them.

(*iv*) *Nursery Work.*

In the Gorakhpur division an experiment was carried out to determine the most profitable length of root for root-and-shoot cuttings of teak when taken from the nursery for transplanting into the forest. Roots of varying lengths from 6 to 18 inches were tried and after one season very little difference was observable except that those with 6 inch roots have not produced quite such good height growth. The others have all produced healthy shoots 1—3 feet high, and consequently a length of 12 inches has been adopted for future forest work in this division.

Each year there is a noticeable increase in nursery activity throughout the plains divisions. This is necessitated by the annual extensions of plantation work and artificial regeneration in general. New nurseries are yearly springing into existence in many divisions, as for instance in the Haldwani division where three new nurseries have recently been started.

A new garden has also been started this year by the Silviculturist at Clutterbuckgunj and a start has been made in—

(*a*) testing the viability of seeds of important forest species.
(*b*) finding the quickest and the best method of germinating teak seed.
(*c*) testing the relative suitability of teak grown from seed obtained from Burma, Jhansi (United Provinces) and Hoshangabad (Central Provinces) to the climatic conditions which prevail in this province.

(*v*) *Artificial Regeneration.*

In the Saharanpur division the artificial regeneration of miscellaneous Bhabar forests constitutes one of the main problems. chital, pig and porcupine and even a 5-strand barbed wire fence The plantation areas are very subject to damage from sambhar, does not keep these animals out satisfactorily. At present the only species found suitable for transplanting, whole or as cuttings, are teak, *sissoo*, *Albizzia Lebbek* and *Dendrocalamus strictus*, and these species are used on a large scale. Direct sowings are made in beds previously prepared $6 \times 3 \times 1\frac{1}{2}$ feet and left with the soil thrown to one side to aerate. *Haldu* (*Adina cordifolia*) and *khair* (*Acacia Catechu*) are largely sown, but results with the former are very uncertain.

Several divisions again report failure to have resulted from direct sowings of *Dendrocalamus strictus*, and transplanting one-year old plants from the nursery certainly seems the safest method. However in the Lansdowne division offsets have been tried for some years with the following success:—

Out of 100 offsets put in 1922, 46 still survive.
Out of 200 offsets put in 1923, 20 still survive.
Out of 300 offsets put in 1924, none.
Out of 2,500 offsets put in 1925, 1,185 still survive.

Moreover rhizomes planted at 10 feet intervals in the Dolpokhra plantation, Haldwani division, are also reported to have done well so that under certain conditions, such as where rapid growth is necessary in order that the bamboo may compete with the surrounding growth, offsets may be preferable. In a plantation situated in the Betali chaur near Jaulasal in the Haldwani division of all the species tried so far root-and-shoot cuttings of *Albizzia procera* are reported as having done best, though porcupines have been troublesome. This chaur is an extensive grassy plain approaching the Tarai formation.

More than one officer continued experiments during the year in trying to solve the problem of transplanting *haldu* (*Adina cordifolia*), but no definite success has yet been reported. In June 1925, 2,000 one-year-old seedlings were transplanted from the Haldwani nursery and planted under a light overhead cover in a fenced area of Chaunsila block in the Ramnagar division. The natural forest area is of mixed miscellaneous species including *khair* (*Acacia Catechu*), and the soil is a recent boulder detritus. The plants were removed whole without pruning and every precaution was taken to ensure success. In spite of this the number of survivals on 1st April 1926 was only 5 per cent.

As reported in previous years *sissoo* (*Dalbergia Sissoo*) is propagated with great success by means of root-and-shoot cuttings. These are usually put out in the forest when one year old, but in the Gonda division it has been found that two year old plants are more successful. The deciding factor seems to be the thickness of the stem which should preferably be that of a man's finger.

The Silviculturist has now commenced a study of the rate of growth of root-and-shoot cuttings of *sissoo* as observed in the nursery at Clutterbuckgunj. The cuttings, 2,200 in number, were spaced 5 feet apart in holes dug 15 inches deep and they have been irrigated on alternate days from a tank. They were put in on 20th February 1926 and the following observations are of interest:—

Date.	SUBSEQUENT OBSERVATIONS.					
	Failures.	Maximum height. inches.	Over 1 foot.	Over 2 feet.	Over 3 feet.	Over 4 feet.
1926.						
30th March . . .	..	15	2	..	..	..
23rd April . . .	307	..	496	7	..	..
30th April . . .	307	28	501	8	..	..
7th May . . .	315	28¾	510	11	..	..
15th May . . .	309	36½	1,009	45	1	..
31st May . . .	307	44	1,079	58	12	..
15th June . . .	300	46	1,099	67	17	..
30th June . . .	313	48½	994	299	29	1

(*vi*) *Reclamation and Afforestation.*

An area of 2,100 acres was added in the Afforestation division during the year. The cost of afforesting this ravine land averaged Rs. 58 per acre which is slightly less than last year. The Divisional Forest Officer reports as follows on some of the principal species used:—

Dendrocalamus strictus.—Nursery transplants give good promise, but the great danger is of drought from April to June.

Acacia Catechu.—This species gives better promise than *babul* (*Acacia arabica*). Seedlings develop very slowly for 2 years and then shoot ahead.

Albizzia Lebbek.—Very promising and especially useful in shallow soils.

Acacia arabica.—Gives excellent results at first but is often disappointing later on. Frost kills it, whilst porcupines and rats do much damage in the younger stages. When about 10 years old a large proportion of trees develop cracks in the bark which splits off and the trees slowly die.

Dalbergia Sissoo.—Continues to give good results both from seed and cuttings. This is undoubtedly the tree of the future.

Butea frondosa.—Seedlings are much attacked by porcupine and other pests. Experiments with root-and-shoot cuttings have given fair results.

(*vii*) *Thinnings and Cleanings.*

It has been the practice for some years in certain divisions to cut back *rohini* (*Mallotus philippinensis*) either level with the ground or at a height of a few feet in operations subsidiary to the main fellings. It is now realised that in most cases the bush which results from such treatment develops a larger, lower and more spreading crown than the original tree, and it is found preferable to restrict fellings to the removal of all but one of the shoots and thus encourage the development of a higher crown. It has been abundantly shown in many localities that the mere cutting back of *rohini* even under a dense overhead canopy will leave no permanent effect in eradicating this species. Cutting back and then burning the debris acts as a serious set back, but is still insufficient to have any lasting effect. If, however, this operation was followed by controlled annual burning it is probable that a greater measure of success would be achieved.

(x) *Silvicultural Systems.*

Recent working plans for *sal* under conversion to the uniform system have laid down three periodic blocks. Under this arrangement the comparatively long period allotted for the complete regeneration of Periodic Block I was considered to be valuable and necessary in order to allow for the probable time it would take to obtain *sal* regeneration and nurse it until it arrived at the stage when it was ready to form continuous height growth. These plans did not recognise the advisability of obtaining regeneration in Periodic Block II. In two of the more recent working plans now under construction this arrangement has been slightly altered. Instead of 3 there will be 4 periodic blocks and the functions allotted in the former arrangement to Periodic Block I will, under the latter arrangement, be allotted to Periodic Blocks I and II. Thus prescriptions for Periodic Block II will be mainly with reference to securing complete seedling regeneration. The principal prescriptions will be controlled burning, increment and other fellings corresponding to seedling fellings in the overwood, and cutting back the underwood where dense. For Periodic Block I prescriptions will aim at preserving the younger regeneration until it arrives at the stage when, with a stem about as thick as a man's finger, it may be counted on to respond to the removal of the overwood and to develop unchecked into a sapling. It is claimed for this alteration in the system that the separation of the functions previously combined in Periodic Block I will make it simpler for the Divisional Forest Officer to lay down the proper management for each separate unit.

II.—WORKING PLANS AND STATISTICS.

(ii) *Yield Tables.*

As mentioned in last year's report, measurements had been started with a view to calculating the increment of *sal* areas included in Periodic Block I. For this purpose areas of 80 to 100 acres were selected in the Ramnagar and Dehra Dun divisions. Enumerations were carried out in 1″ diameter classes. Results will not be available till 1931 when these areas will be remeasured and the increment calculated. Further work along these lines has now been abandoned, as it was found that the error involved in taking the increment figure from a yield table is so small that enumerations on a large scale are not justified. Moreover since the volume of these areas is to be calculated by means of a volume table this work, in effect, implies the checking of the yield table by the volume table.

Sample plots.—A quinquennial scheme for the measurement of sample plots has been drawn up for the Province. The scheme has been drawn up in such a manner as to concentrate the work in 2 or 3 adjoining divisions and in this way much time and expense in touring will be saved. New sample plots will also in future only be laid out in those divisions where the measurements of old plots are being carried out. This will insure a fixed period of remeasurement of these plots after every 5 years. The following permanent sample plots were remeasured during the working season—

Division.	Sal.	Shisham.	Chir.	Banj.	TOTAL.
Haldwani . . .	16	8	..	..	24
Almora	..	..	12	6	18

Out of these plots 3 were abandoned in the Haldwani and 2 in the Almora division.

Sixteen new sample plots were laid out during the year.

(*iii*) *Volume and Form Factor Tables.*

With the ultimate object of compiling a volume table for banj oak some statistics were collected during the year at Dalmoti in the Ranikhet division.

CENTRAL PROVINCES.

I.—EXPERIMENTAL SILVICULTURE.

(*i*) *General.*

Since the last report was written the suggested Working Plans Division has now become a reality, and with its formation attention has been concentrated on problems of regeneration in teak and *sal* forests.

Regeneration plots have been established in North Chanda (4 plots), Betul (3 plots), Seoni and Balaghat.

Statistical work for the moment is not as important as the immediate problems of regeneration, in view of the fact that wherever possible more uniform systems of management will be introduced with the new working plans.

(ii) *Natural Regeneration.*

(*a*) *Teak.*—Reproduction of teak under ordinary conditions presents little difficulty. Exceptional factors such as over grazing and heavy fires are matters of local adjustment and with such things under proper control no great difficulty is likely to be experienced in teak regeneration, except in special cases where the conditions are unusual.

Such a case is the old Moharli Range (400 square miles) of North Chanda Division where many of the better soils (all Vindhyan and Kampti sand stone) carry an overwood of teak forest or mixed forest with *bija* (*Pterocarpus Marsupium*) and teak in varying degrees of mixture; the underwood is frequently a dense mass of poor quality bamboos (*Dendrocalamus strictus*) which completely precludes all regeneration. It is also very noticeable that, where the bamboos are absent or sparse, natural regeneration, at any rate of teak, is good. Four experimental plots have been laid out in the densest type of bamboo forest with the object of obtaining complete natural regeneration, two plots were in typical teak forest and two in typical mixed forest with *Pterocarpus Marsupium* and teak. The bamboos were clear felled and the canopy opened up to a extent rather greater than a D-thinning, the undergrowth being clear felled; such material as was saleable was removed and the balance thoroughly burnt.

It was noticed during a tour in Seoni Division that teak occurred in practically pure strips, sometimes extending for a quarter of a mile in length and 50-100 yards in depth, interspersed with similar strips and areas of non-teak forest. Whether this is due to sudden changes in soil and sub-soil formation or to merely physical phenomena (such as changes in aeration, water-level, acidity etc.) is a problem worth investigation.

(*b*) *Sal.*—Work in the South Raipur Division continues to be most instructive. It is now more or less admitted that, to regenerate naturally a given area, regeneration in an established state must be obtained before the main canopy is seriously interfered with; the canopy must not be opened so much that grass and weeds can establish themselves, or *sal* regeneration will not appear. The natural habit of *sal* appears to be that the regeneration grows and establishes itself below the parent trees even under a very dense canopy. When such regeneration is absent it is impossible to obtain it naturally by any quick methods. The procedure must be a search for the reason of its absence and the removal or counteraction of the adverse influences.

In the South Raipur *sal* forest these adverse influences appear to be heavy (but fortunately localised) grazing, and it is hoped that closure to grazing, together with annual burning of the leaf-layer, and soil loosening, will result in regeneration; but it is anticipated that success will come very slowly.

The Banjar Valley Reserve (in Mandla) continues to show the opposite extreme and all attempts to establish natural regeneration anywhere have failed. This is very curious, for the Baihar forests higher up the same valley and under much the same conditions of climate and soil usually contain fair to dense regeneration. Exceptions are, however, noted in the case of woods with a dense undergrowth. One experimental plot has been laid out in II quality nearly mature *sal* forest with a dense undergrowth of *Flemingia*, and no regeneration, with the object of restraining or destroying the undergrowth so that *sal* can establish itself; cutting and burning is being tried.

(*v*) *Artificial Regeneration.*

(*a*) *Teak.*—The two experimental plots in Seoni Division were on the whole a failure. Some of the unweathered teak seeds sown in May and June 1924 have come up. Seeds collected and weathered last year have been sown this year.

The work on teak plantations in both North and South Raipur divisions shows great promise. Some details of the latter are available. Five acres of I quality alluvial soil carrying a mixed crop of little value was clear felled in 1924 and sown up with teak before the rains. Germination was slow and irregular and the resulting seedlings were only a few inches high in October. The plantation put on an astonishing growth during the rains in 1925 and in October of that year about one acre is reported to be fully stocked with teak of 12 feet average height, three acres being moderately stocked and one acre poorly stocked. Blanks are about to be filled up. The work suffers from inexperience, and the cost is at present high (Rs. 100 per acre) but it is known that this will be very greatly reduced with more experience.

(*b*) *Sal.*—All attempts to obtain *sal* regeneration in the blanks and understocked areas of worked coupes of Periodic Block I in South Raipur have been comparative failures; pit sowings, line sowings and seed scattering over ploughed land alike have given successful germination, but the seedlings have failed to maintain themselves despite weeding until the next rains.

Fortunately the patches involved are small, and in the only large one Nature is stepping in, and there is some hope that the whole of the understocked area may fill up with natural seedlings of *Pterocarpus Marsupium.*

(*c*) *Chir Pine* (*Pinus longifolia*).—The extension of the existing plantations at Supkhar in Balaghat is being continued. Half of the area in the current year's plantations was covered with grass taties and the other left open. Very little difference was observed in the number and quality of the two sets of seedlings. This is probably due to the wetness of the past year. This Himalayan species appears to be useful in the Central Provinces for afforesting blanks.

(*d*) *Other species.—The anjan* (*Hardwickia binata*) plots in Nimar have been abolished and their results written up.

The agri-silvicultural regeneration of *babul* forests continued with varying degrees of success, and various species were tried besides *babul* (*Acacia arabica*). Work at present lacks co-ordination and it is hoped to take the matter up seriously soon.

II.—WORKING PLANS AND STATISTICS.

(*i*) *Working Plans.*

In October the Working Plans Branch of the Central Provinces was organised and placed in the charge of an officer working directly under the orders of the Chief Conservator. The field work of four working plans was in progress at the time namely Betul, Seoni, North Chanda and South Raipur. The main organisation work apart from the creation of the office, consisted in the co-ordination of the work and the introduction of standard methods of stock-mapping and standard conventional signs; in the recent past methods had been left to local officers which resulted in considerable variations in degree of detail shown, and on occasion some confusion in conventional signs used on maps. The conventional signs now standardized use colours to show species or type of forest; for showing quality classes the colours are used in different ways *e.g.*, vertical single lines to show I quality, horizontal double lines to show II quality etc. It is now realised that one of the most important points in stock-mapping, especially in poorer quality forests, is the mapping off of blanks and areas so badly stocked as to be incapable of improvement by any silvicultural operation other than artificial restocking. The rate at which detailed and reliable stock-mapping can be carried out shows considerable improvement with experience. An average of 500 acres daily by each stock-mapper, mapping down to 5 acres, can be more or less relied on, though it varies considerably with density and terrain.

(ii) *Yield Tables.*

During the year one permanent volume per acre teak sample plot was laid out in Betul Division.

(v) *Miscellaneous.*

The bamboo nurseries and transplanting were continued in Akola with fair success.

The Balaghat Nazul forest reclamation and afforestation plots show nothing worthy of report for the present.

PUNJAB.

I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

Research in connection with matters of silvicultural interest has been somewhat spasmodic.

There is a serious shortage of experienced staff and most of the Divisions are held by inexperienced officers who find their time fully occupied in mastering the difficulties of the routine control of their charges. A Working Plan and Research Branch was sanctioned some years ago, and certainly, so far as the compilation and control of Working Plans is concerned, formation of the branch must no longer be deferred.

The necessity for initiating research, for guiding, and for co-ordinating the efforts of individual officers becomes yearly more apparent.

(ii) *Natural Regeneration.*

The more valuable coniferous species, *Cedrus Deodara*, *Pinus excelsa*, and *Pinus longifolia* regenerate naturally where conditions of light and seed bed are suitable. For many years past the conditions favouring natural regeneration have been the subject of constant study and they are generally sufficiently understood.

This is not the case with spruce (*Picea Morinda*) and the silver fir (*Abies Webbiana*) and experiments to obtain natural regeneration in mature forest have proved either abortive or contradictory; it is by no means certain that the correct treatment has been discovered.

In the alluvial *sissoo* (*Dalbergia Sissoo*) forests in the Plains, clear felling followed by trenching has resulted in a fine crop of root suckers in many places where natural regeneration and artificial sowings had failed.

(*iv*) *Nursery Work.*

The ravages of the fungus *Fomes lucidus* on the *sissoo* in the irrigated plantations has rendered it imperative to find some timber tree which can supplement the *sissoo* in these plantations; otherwise they will shortly contain only pure mulberry.

Exotics have generally failed largely on account of the severe winter frosts, and experiments with various species of *Eucalyptus* have met with only a modicum of success. Most of the *Eucalyptus* plants were formerly obtained from the Lawrence Gardens, Lahore, where they are grown in pots in which their root system has little room to develop; this was thought to be the one of the main causes of failure. Various species have been raised in seed beds of good and well-aerated humus soil, and in one year plants have reached a height of 12′ to 15′. These plants have been converted to "root and shoot" cuttings and planted out in the forest and their future growth will be watched with interest.

(*v*) *Artificial Regeneration.*

Hill forests.

In the hills little experimental work has been done as the natural regeneration of the main species worked is fairly adequate. In the Patriata Reserve, however, which consists of broad-leaved species used for the important Murree firewood supply, numerous attempts are being made to establish artificially both indigenous and exotic species.

Irrigated Plantations.

New irrigated plantations are being established in several localities and Divisional Officers in charge are constantly seeking to cheapen the cost of planting and sowing, to discover methods to deal with unfavourable soils, to economise irrigation water, and to make the best use of ground for agricultural crops until the seedlings are established.

These experiments are of great value and it is hoped to publish results separately.

(*vi*) *Reclamation and Afforestation.*

Afforestation in the Pabbi hills near Jhelum was held in abeyance for want of funds.

(*vii*) *Thinnings and Cleanings.*

Thinnings and cleanings are routine operations in all deodar, blue pine and *chir* woods. Sample plots in most Divisions are maintained by the Imperial Forest Research Institute, Dehra Dun, in order to ascertain the effects of various degrees of intensity of thinnings.

In irrigated plantations thinnings now sometimes begin when the crops are only three years old, as soon, in fact, as the sale of the outturn can cover part at least of the cost of the operation.

II.—WORKING PLANS AND STATISTICS.

The preparation and revision of the plans has perhaps been more rapid than was justified without a regular Working Plans Branch. Junior officers with little practical experience have been allowed to compile plans which have not been capable of application.

BENGAL.

I.—EXPERIMENTAL SILVICULTURE.

(*i*) *General.*

The post of Provincial Silviculturist was held by Mr. C. K. Homfray, Deputy Conservator of Forests, throughout the year.

Work was continued on the same lines as in the previous year, and the thinning of *sal* plantations in the Dooars and Terai was taken up both experimentally and on a large scale and took up most of the cold weather season.

The Silviculturist toured in all Divisions except Cox's Bazar and Dacca-Mymensingh, and visited Dehra Dun in August 1925 for a month to study the systems of working up sample plot measurements and ledger filing in use at the Research Institute.

The Imperial Silviculturist toured in Bengal from January 15th to February 15th, 1926, and visited all Divisions except Cox's Bazar and Dacca-Mymensingh.

The preparation of a revised edition of "Nursery and Plantation Notes for Bengal" has been taken in hand.

(ii) *Natural Regeneration.*

The natural regeneration of mahogany (*Swietenia macrophylla*) in Kaptai Range, Chittagong Hill Tracts, has been extended as a result of cleaning undergrowth and girdling big trees in the neighbourhood of the parent trees.

Two Experimental Plots were laid out in the Sundarbans Division to study the coppice regeneration of *Ceriops Roxburghiana.* One plot was completely clear felled; in the other all stems under 1″ diameter at 3′ from the ground were left standing.

(*vii*) Thinnings and Cleanings.

All the *sal* plantations made prior to 1921 in the Dooars and Terai were thinned under the supervision of the Silviculturist. A number of Experimental Plots were demarcated and thinnings varying from very light to very heavy were made in them. Records of these plots are being maintained.

Sample thinnings were also made in planted crops of *Michelia Champaca, Chickrassia tabularis, Terminalia myriocarpa* and *Bischofia javanica.*

The sowing of *Tephrosia candida* and *Cajanus indicus* between the lines in *taungya* plantations to keep down weed growth has given good results and is now being tried on a much larger scale.

Restricted grazing in young *sal* plantations where grass was troublesome has been tried, but results so far are not promising. Buffaloes are distinctly injurious to the crop, and must be excluded. Cows and bullocks do less damage, but it is still doubtful whether any clear gain results from their use.

(*ix*) *Underplanting.*

Experimental underplanting of *Chickrassia tabularis* with *Michelia Champaca* has been carried out.

II.—WORKING PLANS AND STATISTICS.

(*i*) *Working Plans.*

The Working Plan for Jalpaiguri Division has been completed, and the enumeration of *sal* in the Buxa Division has been finished.

(*ii*) *Yield Tables.*

Sample Plots 1-9 of *Heritiera minor* (*sundri*), in the Sundarbans Division have been remeasured, but numbers 2, 4 and 8 have been found unsuitable as Sample Plots and will be kept for recording Diameter Increment and study of natural regeneration.

New Sample Plots have been laid out as follows:—

Kalimpong . .	I	(*Cedrela Toona*).
Kalimpong . .	II	(*Duabanga sonneratioides*).
Jalpaiguri . .	VIII	(*Cedrela Toona*).
Sundarbans . .	X-XIII	(*Ceriops Roxburghiana*).

Three old Valuation Lines were remeasured and three new ones were laid out in the Jalpaiguri Division. The object is to get facts as to distribution of species in different types of forest and at the same time get some idea of the diameter increment of individual species. Lines about one mile in length and one chain broad were laid out. All trees occurring within this line were numbered and measured at breast height. Difficulty is at present found in identifying all the species.

Parties of computers from Dehra Dun worked in Jalpaiguri and Buxa Divisions collecting data for commercial volume tables for *Shorea robusta* and *Acacia Catechu.*

BIHAR AND ORISSA.

1.—Experimental Silviculture.

(*i*) *General.*

Experimental Silviculture was continued on the lines indicated in last year's report. Fifty nine plots were laid out during the year and five were abandoned. The total number of plots being maintained at the end of the year was one hundred and fifty nine. The results obtained in old plots, and the details of new plots established, are referred to under the different headings below.

In last year's report attention was drawn to the importance attached to experimental work on the effects of fire and fire protection. During the year under report several more experimental observation plots were laid out, and it is hoped that these plots will indicate the necessity or otherwise of complete fire protection.

It was remarked in last year's report that the effect of fire on soil fertility might differ for different systems of treatment, and that, if even-aged systems of management induced the production of more humus, fires might be more injurious than in unevenaged forests. Further investigation has tended to throw doubt on the possibility of the amount of humus being appreciably affected by the system of treatment. The reason is that the building up of organic matter in the soil appears to be almost an impossibility, except on damp soils, owing to the rapidity with which humus is destroyed by white ants. The role played by white ants in forests, such as those prevalent over most of this province, is one which has never been studied, but they have a most decided influence on the regeneration and growth of our forests. On the one hand they assist the process of natural regeneration, as leaf litter is devoured by them as soon as a sufficient amount of rain falls to permit of the leaves being pasted to the mineral soil. On the other hand by their rapid destruction of leaf litter they prevent the formation of humus. We do not know whether the presence of white ants affects the soil fertility beneficially or adversely. On the one hand they improve the physical texture of the soil: on the other hand they may set up acid reactions which inhibit plant growth. If the latter is the case, burning, by reducing the available food for white ants, is likely to be advantageous. The problem is obscure, but one fact seems to emerge, and that is, that except possibly on damper soils white ants tend to nullify the production of humus in fire protected areas, and one great argument against fires, namely that they destroy nitrogenous matter, rather falls to the ground.

(ii) *Natural Regeneration.*

The seven experimental plots which were laid out in Puri division in 1923-24 and 1924-25 to ascertain the possibility of re-inducing *sal* regeneration in *sal* forests of a damper type have not as yet given positive results. Opening up the canopy in strips or groups more than half a chain in width has resulted in a dense growth of grass and evergreen undergrowth. This growth is likely to inhibit the germination of more seedlings and the growth of existing seedlings. The plots have shown that, contrary to local reports, the greatest mortality amongst *sal* seedlings does not take place in the rainy season, but in the cold weather months and beginning of the hot weather, as is the case in dry type *sal* forests. At present the prospects of inducing *sal* regeneration within a reasonable period of time are not very bright, but seedlings now present on the plots may establish themselves quicker than is thought.

The series of plots which were laid out in 1923-24 and 1924-25 to test the effect of fire protection and annual burning on the natural regeneration of *sal* in damp and dry types of forest respectively were added to in the course of the year, nine new plots being established in Saranda division.

The two plots laid out in Angul division in 1923-24 to see whether, in mixed bamboo forest, sufficient natural regeneration of species in the overwood can be obtained by felling and burning the bamboos and valueless species, have shown that the method is effective in inducing the establishment of regeneration of *Adina cordifolia,* but it has so far not been successful in inducing much regeneration of *Termonalia tomentosa.* The plot on the same lines which was laid out in 1924-25 in Porahat Division has given more or less similar results, but in this plot *Pterocarpus Marsupium* regeneration seems to have benefited from the treatment. All three plots were reburnt in 1925-26. A fourth plot on the same lines was laid out in Betla forest in Palamau division, where natural regeneration is deficient and coppice regeneration defective.

The experiments to test whether regeneration of *Casuarina* trees can be secured from pollard or coppice shoots were continued. One plot was laid out in the rains of 1925 in the Puri *Casuarina* plantation. The results were the same as those obtained in the plot laid out in April 1924. Coppice or pollard shoots were produced only when the stumps were protected from sun and wind. Felling by saw and covering the stumps with cowdung plaster had no effect on shoot production. The experiment will be repeated in the cold weather of 1926-27, as it is possible that shoots will be more easily produced at this season.

An experimental plot was laid out in Betla forest, Palamau division, to determine the cause of the poor coppice reproduction which is characteristic of this forest.

An experimental plot was laid out in Kolhan division to test whether good *sal* coppice shoots can be produced from old hollow *sal* trees growing in poor hill type forest.

Two plots were laid out in Kolhan division to determine the effect on shoot production and growth of dressing coppice stumps of miscellaneous species after felling.

A series of five plots was laid out in the same division to determine the vitality and volume of coppice shoots produced under different rotations.

An experimental plot was established in Saranda division to test the possibility of inducing *sal* regeneration in a particular type of open *sal* forest by first establishing an underwood of *Woodfordia floribunda* and *Wendlandia tinctoria.*

In addition to definite experimental research work the conditions under which natural regeneration of *sal* becomes established were studied in different types of forest.

Three plots were laid out in damp types of *sal* forest in Kolhan division with the object of seeing whether interference by weeds with the growth of *sal* regeneration after clear felling can be reduced by burning the area for one or more years previous to felling. These plots are supplementary to those laid out in Saranda division in 1924-25 which were referred to in that year's report under the head " thinnings and cleanings."

The two plots which were laid out in Sambalpur division to test the comparative merits of cutting back and burning back established *sal* regeneration gave rather indefinite results, owing to an accidental fire occurring in the fire protected plot. The results, such as they were, indicated that burning back was more efficient than cutting back. The experiment has now been duplicated.

Two plots were laid out in Sambalpur division to determine the age at which coppice shoots from old stumps interfering with shoots from younger stumps should be cut out. The matter is of some importance in that the side-shade given by coppice shoots from older stumps would appear at first to assist natural regeneration to establish itself, and later to interfere with the growth of the latter. Where " high forest " is the aim it has been considered that shoots from stumps under 4″ in diameter should be favoured against shoots from older stumps, as being more likely to develop into first class trees.

(iv) *Nursery work.*

An experimental nursery was laid out at Ranchi. The object of this nursery is to study the germination and growth of seedlings under different methods of treatment so that standard instructions may be drawn up for the execution of nursery work. So far definite results have been secured only in respect of methods to secure rapid germination in the case of a few species. These results have been as follows :—

Terminalia tomentosa.—For sowings in the rainy season the seed should be heaped up and drenched with water twice a day. The seed germinates in the exuded mucilage in the course of 2 to 3 days. For hot weather sowings this method is not recommended as under dry climatic conditions the seed does not retain moisture unless covered by straw in which case it does not obtain sufficient heat. Germination in the hot weather under this method took fifteen days—a day or two longer than seed sown directly in a germination nursery bed.

Butea frondosa.—If the seed is removed from the pod germination occurs in three days' time as against four days required if the pods are simply broken across and the seed not removed. The latter method is recommended.

Zizyphus Jujuba.—The best results were secured by splitting the kernels and soaking the seed for twenty four hours. Germination occurred in five days.

Acacia Catechu.—The best results were secured by removing the seed from the pod and sowing without further treatment. Germination occurred in two to three days.

(*v*) *Artificial Regeneration.*

Sal sowings in lines on the Bengal method were tried on a small scale in Puri and Saranda divisions. The results up to date are promising, but conditions have been somewhat abnormal owing to exceptional falls of rain occurring in the month of March. The indications are, that in damp types of *sal* forest such line sowings will probably prove successful but that in drier types the young seedlings are likely to die back unless protected by side-shade on the south-west. Experimental nursery work on this species is now going to be initiated with the object of seeing whether by special manuring and treatment seedlings with stocky root systems cannot be raised and successfully transplanted. Young transplants of *Amoora Wallichii* were tried in a moist valley bottom in Saranda division but proved a complete failure as the young plants succumbed to drought in the hot weather. The only chance of success would appear to lie in trying one-year-old transplants.

Regeneration of teak by *taungya* methods in Angul division has once more given disappointing results. It is fairly evident that one-year-old root and shoot cuttings are alone likely to give good results.

A further number of experimental artificial regeneration plots were established in Sambalpur and Porahat divisions, the species tried being *Gmelina arborea, Terminalia tomentosa, Dalbergia Sissoo, Melia indica, Pterocarpus Marsupium, Zizyphus Jujuba. Albizzia Lebbek,* and *Pongamia glabra.* A few results are available:—

Gmelina arborea.—Direct sowings are successful in humid localities. On moderately dry sites one- to two-month-old transplants are successful. On very dry sites definite results have not yet been secured.

Terminalia tomentosa.—In swampy localities, such as abandoned paddy fields, both direct sowings on mounds and one- to two-month-old transplants on mounds have given successful results. The transplants have given rather better results than direct sowings.

Pterocarpus Marsupium.—Direct sowings in humid localities give promise of success but they are not likely to succeed in drier localities.

(vi) *Reclamation and Afforestation.*

The plots established in 1924-25 in Sambalpur division with the object of testing the rapidity with which erosion is taking place in a certain type of forest, and the possibility of checking it, gave rather indefinite results as exceptionally heavy rain fell at the beginning of the 1925 rains and many of the protective *bandhs* were washed away. The indications are that with stronger *bandhs* erosion can be successfully checked and the soil rebuilt. *Bandhs* stregthened by brush wood and living cuttings of species such as *Boswellia serrata* are being tried this year.

The results of reforestation work on Larangkud, Sambalpur division, with *Zizyphus Jujuba, Butea frondosa, Acacia Catechu* and *Schleichera trijuga* were very disappointing owing to the carelessness of the range officer in charge. Altogether about 30 acres were planted up with these species but transplanting was carried out badly and much too late. It is doubtful if twenty per cent. of the transplants will survive and the whole area is, therefore, to be replanted this year.

An experimental plot was laid out in Kolhan Division with the object of testing the possibility of cultivating *sabai* (*Ischœmum angustifolium*) grass as a field crop on a commercial scale. Transplanting and direct sowing will be carried out in the rains of 1926.

Two sites for experimental matchwood plantations averaging fifty acres in extent were cleared in Puri and Kolhan divisions respectively. In each plantation ten of the most promising matchwood species will be introduced with the object of obtaining statistics of rate of growth, yield, costs of formation, etc., so that the department will be in a position to advise prospective matchwood planters what species will give the best results.

(vii) *Thinnings and Cleanings.*

A series of twelve plots was laid out in Sambalpur division with the object of determining the best ages and degrees for thinnings in mixed coppice crops up to twenty years age. This series of plots is supplementary to that established in Kolhan division in 1924-25.

Mechanical thinnings of young *sal* sapling and pole crops were carried out in Saranda division. The following rule was found effective for crops of average growth. If saplings 0-1″ in diameter no thinnings are carried out; if 1″-2½″ in diameter all growth within a distance of three feet is removed in thinning; if 2½″-4″ in diameter all growth within a distance of four feet is thinned out; above 4″ in diameter selection thinnings are necessary. It was found that with a four-foot stick, on which the diameter class limits and a length of three feet are marked, an effective thinning could be carried out by a forest guard with practically no preliminary training.

(xi) *Miscellaneous.*

In addition to the plots laid out in 1924-25 two further plots were laid out in Sambalpur division to test the effect of burning after felling on the fertility of the soil.

The three plots which were laid out in Puri in 1923-24 to test the effect on diameter and hight growth of pruning three-, four- and five-year old *Casuarina* trees showed that pruning affected both diameter and height growth adversely. These plots have now been abandoned and the practice of pruning has been discontinued.

II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

The Working plan for Puri division was completed during the year under report, and that for Angul division taken in hand.

(ii) *Yield Tables.*

Eleven *sal* Sample plots were laid out in Puri, Sambalpur, Saranda and Kolhan divisions. Eight teak Sample plots were laid out in Puri and Palamau divisions. Two *Gmelina arborea* and two *Anogeissus latifolia* plots were laid out in Kolhan division. Ten *Terminalia tomentosa* plots were laid out in Saranda, Kolhan, and Sambalpur divisions. The total number of permanent Sample plots in the province at the close of the year was eighty, comprising the following species:—

Sal thirty eight, teak thirteen, *Casuarina* twelve, *Terminalia tomentosa* ten, *Anogeissus latifolia*, five, and *Gmelina arborea* two.

An increasing difficulty has been encountered in selecting suitable sites for *sal* sample plots as the range of forest which includes suitable even-aged crops is very limited. As a result sample plots recently laid out have been rather understocked and reliable figures of volume increment per acre will not be obtainable for a decade or more.

(*iii*) *Volume and Form Factor Tables.*

Data for the compilation of a *sal* outturn table were collected in Angul division, and a start was made in collecting similar data in Saranda division.

One hundred and sixty *Acacia Catechu* trees were measured up with the object of compiling a heartwood table on the basis of which the best rotation of working for *kath* manufacture might be calculated. It was found that the number of trees measured was insufficient for the purpose.

(*v*) *Miscellaneous.*

The Research Officer toured in all divisions, except in Hazaribagh and Angul, during the course of the year.

NORTH-WEST FRONTIER PROVINCE.

I.—EXPERIMENTAL SILVICULTURE.

(*ii*) *Natural Regeneration.*

Chil.—Under the shelter wood compartment system the regeneration of the *chil* is proving completely successful especially in the Siran.

Blue Pine.—Natural regeneration is proving slow and difficult. The conditions required for establishment appear to be light, good drainage and absence of weeds. In weed grown areas grazing would appear to be beneficial or at least not inimical, in that all the densest blue pine crops occur where there is reason to believe that fodder utilization has been the heaviest. Mr. O. H. Walters' observations regarding certain forests in Kulu in the 'Indian Forester' (September 1924) where closure to grazing has resulted in the complete failure of regeneration are supported by evidence in Hazara. This view is in contradiction to Professor Troup's statement in his "Silviculture of Indian Trees " that the blue pine suffers the most of all conifers from grazing. Under certain conditions, *viz.*, absence of natural feed, cattle will " browse " seedlings but it has yet to be ascertained to what extent this damage is counterbalanced by the benefits derived from the keeping down of weed growth. Further speculation tends to suggest that in regenerating blue pine in areas subject to weed growth grazing should be allowed during the seedling establishment period and closed down if necessary during the development period until the leading shoots are out of reach.

This is a complete reversal of the generally accepted theory that grazing is harmful and that closure is a necessary concomitant of regeneration processes. Evidence from other parts of India that this theory is correct would be welcomed.

Olive.—This species had completely failed to produce seed during the autumn of the year 1924. Consequently its natural regeneration was conspicuously absent. The 1924 seedlings which had been observed in the Garmthun and Jaulian reserves, survived the 1925 hot weather only in sheltered situations, and under a heavy cover of mixed brush wood.

The two experimental plots established in Jaulian Compartment V for purposes of statistical information regarding the development of the olive seedlings under variously regulated overhead cover, were kept under observation. Brushwood and overhead cover were not removed during the year from either of the plots in order to ascertain their effect on the height growth of the seedlings. Plot I, in which the brushwood had been completely felled in the beginning, developed abundance of grass and small shrubs, while the moderately heavy overhead cover originally retained in Plot II attained considerable development. The measurements of the seedlings in each of the plots, were recorded in February 1926 with the following results :—

Plot No.	No. of seedlings measured.	AVERAGE HEIGHT RECORDED.		Height increment.	REMARKS.
		On 15th February 1925.	On 26th February 1926.		
Plot I.—(Overhead cover had been completely removed at the start.)	18	2′-3·70″	2′-8·80″	5·10″	Small shrubs and heavy grass. No suppression.
Plot II.—(Moderately heavy cover had been retained in the beginning.)	10	1′-8·20″	1′-10·80″	2·60″	Suppression by overgrown grass and shrubs.

The results recorded during the previous year had shown the beneficial effect of moderate cover on the height growth of the olive seedlings. The adverse effect of allowing the shrubs to overgrow, therefore, is clearly demonstrated by the marked difference in the height increment of the seedlings in plot II.

It is not proposed to continue this experiment.

(*iii*) *Seeds.*

Chil seed.—Fertility tests carried out by the Silviculturist at Dehra Dun prove that seed collected from trees felled in December and later is ripe and will germinate.

(*v*) *Artificial Regeneration.*

Deodar.—Broadcast sowings on burnt patches and subsequent transplanting are proving successful.

Blue Pine.—Every effort to assist this species artificially has failed mainly owing to a *lepidopterous* caterpillar attack which destroys the seedlings soon after germination, and possibly also to the misguided digging of patches in places where drainage conditions are not good. Broadcast sowing on burnt patches on sloping or deep ground, and on similar ground throughout the forest, both with and without wounding of the soil, is now to be tried, coupled with grazing.

Walnut.—All attempts to introduce this species artificially have failed owing to destruction after germination by moles or rats (and probably voles).

Olive.—(1) 6 per cent. of the Soda Caustic solution and 12·5 per cent. of the Sulphuric acid *Aqua* with an immersion period of 72 hours gave the best results. Seed in either case germinated in the second week of July.

(2) Seed which had been treated with weaker solutions germinated last of all; germination began in the third week and was complete in August.

(3) Treatment with the stronger solutions destroyed the germinating power of a considerable proportion of the seed: fewer seeds germinated in the plots, where a known number of the seeds treated with the 25 per cent. solutions had been sown. Germination began in such cases in the first week of July.

(4) Caustic Soda solutions gave better results.

(5) Seeds which had been consumed by birds and hares and collected from their excreta had also been sown in a number of plots

at the same time. Germination which began in this case about the third week of July, was completed only by the third week of October.

(6) Untreated seed sown in the central plots completely failed to germinate till about the middle of October, when only a small number of seedlings appeared in the beds.

(7) Olive seed, whether treated or not, is damaged by wild birds and animals. Seed beds in the open must be covered with thorny bushes to prevent damage. Only the seed treated with 25 per cent. caustic soda solution appears to escape their attentions.

(*xi*) *Miscellaneous.*

Burning of chil regeneration areas.—The density of *chil* regeneration in the Siran Periodic Block I areas and the resulting danger from summer fires have suggested periodic winter departmental burning of such areas. Ten acres were so treated in Batrassi without damage to the seedlings. A similar attempt in Khanpur in an area protected from fire and covered with thick grass naturally resulted in a high mortality among the seedlings. There is certain evidence in Hazara that fire is a necessity in the establishment and successful development of *chil* regeneration.

The theory has been elaborated in a recent contribution by Mr. E. A. Greswell to the "Indian Forester" which appears in the October number.

II.—WORKING PLANS AND STATISTICS.

(*i*) *Working Plans.*

1. Revised Khanpur Working Plan, by Pt. Mehr Chand, Extra Assistant Conservator of Forests.

2. Revised Gali Cantonment Forests Working Plan, by the same author.

3. Gidarpur Guzara Working Plan, by Khan Mohammad Khan, Extra Assistant Conservator of Forests.

Under preparation.

1. Revised Upper Siran Working Plan, by E. A. Greswell, Deputy Conservator of Forests.

2. Agror Working Plan, by the same author.

CHAPTER III.

BOTANY.

Central Institute.

The Forest Botanist Mr. R. N. Parker, Deputy Conservator of Forests, Punjab, held charge of the branch up to 29th January when he proceeded on leave. Mr. B. L. Gupta held charge of the current duties of the branch from 30th January.

Systematic.—An authoritative account of five species of *Dipterocarpus* was drawn up by Mr. Parker and illustrated with plates prepared from materials known to have come from a single tree of each species. This is ready for the press but it has been decided that publication shall be postponed as the Forest Botanist will be able to see some of the specimens in European herbaria when on leave, and, it is hoped, will be able to clear up the synonymy in the case of Indian species which have also been described from neighbouring countries.

Mycology.--The study of the root disease of *sissoo* is being continued and inoculations with a species of *Fusarium* have been made and preliminary results obtained. The Forest Botanist paid a short visit to Changa Manga, Tera and Daphar plantations in this connection. Evidence is gradually being accumulated to show that *Fomes lucidus* is not the primary cause of the death of *sissoo* in the plains but follows an attack by a *Fusarium.*

A note on the occurrence of *Cronartium ribicola* in India and its relation with *Peridermium brevius* on *Pinus excelsa* has been prepared but its publication has been postponed as the result of inoculations is expected to be known shortly.

Studies on the diseases of *Quercus dilatata, Aleurites Fordii, Bassia latifolia* and *Pterocarpus Marsupium* are being continued but have given no results so far.

A descriptive list of the Forest Fungi of India has been completed.

Herbarium.—6,430 specimens were added to the collection during the year.

Large additions have been made to the Burmese material as the exploration of the Burmese flora is receiving much attention since the appointment of a Forest Botanist for Burma.

Three hundred and fourteen sheets of Bombay grasses were sent on loan to the Rev. E. J. Blatter. 119 sheets of *Juniperus*, 12 of *Stellera*, 28 of *Wikstroemia*, 107 of *Plantago*, 60 of *Daphne* and 347 sheets of *Cruciferæ* including most of our material of the genus *Draba* were sent on loan to experts monographing these genera for Engler's Pflanzenreich.

Exchanges with foreign herbaria have been continued and valuable contributions have been received from the Arnold Arboretum; the United States National Museum, Washington; the Botanical Institute, Imperial University, Tokyo, Japan; and the National Herbarium of Victoria.

Six hundred and fortynine specimens were identified for forest officers and others. As usual, this number represents only those specimens regarding which official letters are issued. Identification work done for other branches of the Institute, or for visiting officers bringing specimens with them for naming, is not included.

Seed indents.—Eighty-five consignments of seeds weighing over 1,846 lbs. were despatched to various correspondents in and outside India in fulfilment of indents during the year.

Drugs.—Specimens of four species of *Berberis* likely to be used medicinally were supplied to the Research Laboratories of the Pharmaceutical Society together with botanical specimens in authentication. It is probable that all these species yield the drug of commerce but it remains to be seen whether it is possible to distinguish them as sticks about an inch thick and a foot or two long. Some of the produce that comes on to the market and has been supposed to be *Berberis* has proved to be *Coscinium fenestratum.*

Arboretum.—Hitherto it has not been possible to start planting systematically and attention has been paid to a few families only. These few families are now represented by about 100 species of trees or shrubs.

It is hoped next year to start the work more systematically and arrangements have been made to grow plants belonging to the first 33 families taken in the order of Bentham and Hooker's Genera Plantarum, in so far as these families contain trees or shrubs likely to thrive in Dehra Dun. A considerable number of plants are ready for planting and record is being kept of every thing tried so that in future efforts may not be wasted in trying to grow plants that have repeatedly failed.

Library.—One hundred and thirty books (excluding duplicates) and 127 volumes of periodicals were added to the Botanical library during the year.

Education.—Lectures were given as usual to the Provincial Classes during the rains by the Assistant to Botanist Mr. B. L. Gupta.

Tours.—The Forest Botanist toured in Etawah in the United Provinces in August, and Changa Manga, Tera and Daphar plantations in the Punjab in October.

BURMA.

BOTANY.

Staff.—The post of the Forest Botanist was held throughout the year by Mr. C. E. Parkinson, Extra Assistant Conservator of Forests. Two Forest Rangers Maung Po Chin and Saw Maung Mya were attached to the Forest Botanist, from the Burma Forest School, in the month of May 1925.

The remaining Forest Establishment consisted of Senior Assistant Gardener, Maung Ba Pe and Head Forester Maung Po Khant.

Maung Kan held the post of Curator during the year and was assisted by Maung Ba Lwin, Botanical Assistant. Maung Ba Pe was Camp Clerk from the month of July 1925.

Building.—The Herbarium and office of the Forest Botanist were moved from the Seed Store of the Botanic Garden to the present office building (formerly occupied by the Commissioner, North-East Frontier Division). Ample accommodation is at present available.

Herbarium.—The re-arrangement of the Herbarium according to the system of Bentham and Hooker's *Genera Plantarum* was completed during the year and instead of the former arrangement of having 3 separate sections, one each for trees, herbs and seedlings, all is now combined in one.

There were 7,005 specimens in the Herbarium at the close of the year. The chief contributions were made by Messrs. R. N. Parker, W. A. Robertson, C. W. Scott, C. R. Robbins and H. R. Blanford and from the collections of the Forest Botanist and his staff. In addition to these many old specimens—the collections of Mr. C. G. Rogers and others—were identified and added to the Herbarium. Of the additions made to the Herbarium during the year 150 species were unrepresented before.

Seven hundred and twenty-nine specimens were identified (or the Maymyo identifications confirmed) by the Forest Botanist, Forest Research Institute and College, Dehra Dun, 409 by the Director, Royal Botanic Gardens, Calcutta, and 247 by the Director, Royal Botanic Gardens, Kew.

One thousand three hundred and eighty-five specimens were distributed to other herbaria during the year, chiefly to Dehra Dun, Kew and Calcutta.

Tours.—The Forest Botanist toured during the months of November and December in the Myitkyina Division and during the months of January to March 1926 in South Tenasserim. 420 botanical and 101 timber specimens were collected by him during this time.

Forest Ranger Maung Po Chin toured in the Upper Chindwin Division and Forest Ranger Saw Maung Mya in the Katha and Myitkyina Divisions and Senior Assistant Gardener Maung Ba Pe in the Insein and Pegu Divisions. Large collections of botanical and timber specimens were made by them and in addition they specially collected material and information for the investigation of the medicinal value of the fruit of various kinds of *kalaw* (*Taraktogenos Kurzii* and allied species).

Thirty-one packets of seeds were collected and distributed during the year chiefly to the Botanical Garden, Maymyo.

CHAPTER IV.

FOREST ECONOMY.

Central Institute.

1.—General work of Administration.

The second year of work at the New Institute at Kaulagarh was one of increased activity.

2. Mr. H. Trotter held charge of the branch, unaided, until the end of November, when he was relieved by Mr. C. C. Wilson, Conservator of Forests, Madras Presidency, and proceeded on long leave at the end of December 1925. Mr. J. L. Harrison, Forest Engineer, Coorg, took over the duties of Assistant Forest Economist on the 20th March 1926.

3. The Paper Pulp Section remained under the charge of Mr. W. Raitt with Mr. M. P. Bhargava as his assistant.

4. The Timber Testing Section was in the charge of Mr. L. N. Seaman till the 10th May 1925 when he went on leave; thereafter Mr. C. R. Ranganathan, I.F.S., from Madras, his Assistant, held charge from the 11th May 1925 to the 6th November 1925, when

Mr. L. N. Seaman returned from leave and took charge again under a renewed agreement for five years, and Mr. Ranganathan continued as his Assistant.

5. The organization of the work and the erection of the machinery in this section having been well in hand by the beginning of the year, it was possible to show a greater outturn of work than previously.

6. In the Wood Preservation Section Capt. J. H. Warr held charge throughout the year and Mr. S. Kamesam held the post of Assistant. Considerable advance was made in the treating of various suitable timbers for use as sleepers, and in persuading the railways to try consignments of these, with the result that the elimination of the use of foreign timbers for sleepers appears at last to be in sight.

7. The Seasoning Section continued in charge of Mr. Stanley Fitzgerald during the year, with the exception of a period between June 6th and November 6th, while he was on leave. During this interval his assistant, Dr. Kapur, held charge. A new and valuable project which consists in seasoning a large quantity of various timbers, other than teak, for trial in building railway carriages, wagons, etc., was initiated, with the help of the Timber Advisory Officer to the Railway Board.

8. The Section of Wood Technology was, most unfortunately, vacant, except that Dr. Brown of the New York State College of Forestry at Syracuse University, United States of America, continued to collaborate with Mr. R. S. Pearson, formerly Forest Economist, in the preparation of their book on 'Indian Timbers.' Dr. Brown was formerly on the staff of the Forest Research Institute at Dehra Dun. The work of the Wood Technologist was carried on by the Forest Economist and the Assistant Forest Economist as occasion demanded.

9. The Wood Working Section remained under the able and energetic guidance of Mr. W. Nagle.

10. The Section of Minor Forest Products was held in abeyance throughout the year, the current work being done by the Forest Economist himself.

11. A detailed account of the working of each section is given below.

12. A very large number of enquiries on many different subjects was received during the year from the general public, and from the

Forest Departments of the various provinces and Indian States. The Indian Railways have been in close touch with the Institute, and, as a result of Mr. Norman White's enquiry, important experiments have been started in connection with the seasoning of various timbers for trial in railway carriage building, with the intention that they should replace expensive teak and other timbers imported at present for this purpose. Many thousands of tons of timber are used annually in railway carriage and wagon building in India, and there is here a suitable market for many of our good but little-known cheaper timbers.

13. The Royal Air Force has also consulted us on several occasions with reference to substitutes for the various timbers that they now use, as supplies are either growing scarce or are becoming expensive. Enquiries have been instituted into the possibility of finding such substitutes.

14. It has long been under consideration, and has now been decided, to erect further Timber Testing apparatus in the form of box testing machinery. In the Seasoning Section the erection of a new form of kiln, known as the Forcell's kiln, is under consideration. Its importance lies in the possibility of seasoning timber up to 6″ and more in thickness in two or three days, instead of two or three months.

15. A large number of the members of the public visited the Institute, the Museums and the Workshops and many of them showed great interest in the work that was being done. Among the more distinguished visitors were His Excellency the Viceroy and Lady Irwin, His Excellency the Commander-in-Chief, Sir Peter Clutterbuck, Inspector General of Forests, Sir B. N. Sarma, Sir Muhammad Habibullah, Mr. Bhore and the Nawab of Chhatari.

II.—Experimental and Commercial Activities.

1.—*Section of Wood Technology.*

As pointed out last year Mr. Pearson and Dr. Brown have undertaken the preparation of a book on Indian Timbers. This work is still in course of preparation.

Enquiries are received almost daily with which a good and thoroughly trained Technologist is the only man competent to deal. The absence of such an officer at this Institute is a serious handicap, and it is hoped that at an early date the appointment of a suitable man will be made.

2.—*Section of Timber Testing.*

The amount of research work accomplished in this Section during the year shows a considerable increase over the previous year. During 1925-26 the outturn amounted to 22,298 mechanical tests and 22,063 physical determinations as compared with 17,648 and 16,897 for the previous year. This is due partly to increase in equipment and partly to the fact that progress made in the training of the staff has made possible a better daily average of work.

The research during the year has been conducted under Projects No. 0, 1, 2, 3, 4 and 6.

Project No. 0 is conducted along similar lines to Project No. 1 and includes all minor investigations generally conducted for the purpose of answering particular enquiries. The principal studies during this year related to timbers suitable for hammer-handles, picker-arms, sucker-rods, tea—and rubber-boxes and tail-skids for aeroplanes. A certain amount of work under this project was also done supplementary to Project No. 1 and Project No. 4.

Project No. 1 covers the routine testing by methods now standard in Canada, the United States, England, the Philippines, Australia, New Zealand and South Africa, of small clear specimens. The results of this project serve as a reliable basis for the comparison of different species of timber, both native and foreign, and as a starting point for practically all other investigations directed towards the establishment of strength data.

Project No. 2 is concerned with the testing of full-sized structural timbers, and supplies reliable data for use in design, and in the preparation of tables of working stresses.

Project No. 3 relates to the testing of vehicle-parts and was started only at the end of the year. Work will continue through the following year.

Project No. 4, which is being conducted in co-operation with the Sections of Wood Preservation, Seasoning, and Wood Technology, is a study of Indian sleeper woods, this Section supplying data as to the Mechanical strength and spike-holding properties of the timbers investigated.

Project No. 6 belongs properly to the Wood-Working Section with which the Timber-Testing Section co-operates in testing the strength of glued joints.

The following is a table of the number of tests completed during the year under the various heads:—

Months.	MECHANICAL.						PHYSICAL.					
	Proj. 0.	Proj. 1.	Proj. 2.	Proj. 3.	Proj. 4.	Proj. 6.	Proj. 0.	Proj. 1.	Proj. 2.	Proj. 3.	Proj. 4.	Proj. 6.
April, 1925 .	447	546	370	..	334	..	92	621	795	..	231	..
May, 1925 .	334	907	333	..	446	..	545	753	543	..	221	..
June, 1925 .	460	1,021	207	..	181	..	515	1,265	545	..	48	..
July, 1925 .	169	1,422	288	..	265	..	257	1,233	474	..	24	..
August, 1925 .	..	947	332	..	224	..	102	1,214	642	..	236	..
September, 1925 .	..	908	386	..	305	..	26	840	797	..	220	..
October, 1925 .	82	956	245	..	467	..	92	913	699	..	118	..
November, 1925 .	40	645	268	..	1,068	..	105	800	579	..	459	..
December, 1925 .	376	439	40	..	606	15	102	509	123	..	323	15
January, 1926 . .	318	481	367	..	707	16	207	514	350	..	551	16
February, 1926 .	694	331	43	3	1,054	..	730	311	335	..	244	...
March, 1926 .	749	817	..	..	639	..	364	861	..	..	504	..
TOTAL .	3,669	9,420	2,879	3	6,296	31	3,137	9,834	5,882	..	3,179	31
GRAND TOTAL	22,298						22,063					

The timber tested up to the present time under projects 1, 2 and 4 are as follows:—

Project No. 1.

No.	Green.	No.	Air Dry.	No.	Kiln Dry.
1	*Tectona grandis.*	1	*Tectona grandis.*	1	*Tectona grandis.*
2	*Terminalia tomentosa.*	2	*Terminalia tomentosa.*	2	*Terminalia tomentosa.*
3	*Dipterocarpus turbinatus.*	3	*Dipterocarpus turbinatus.*	3	*Dipterocarpus turbinatus.*
4	„ *alatus.*	4	„ *alatus.*	4	„ *alatus.*
5	„ *tuberculatus.*	5	„ *tuberculatus.*	5	*Cedrus Deodara.*
6	*Cedrus Deodara.*	5	*Cedrus Deodara.*	6	*Anogeissus latifolia.*
7	*Anogeissus latifolia.*	7	*Anogeissus latifolia.*	7	*Artocarpus hirsuta.*
8	*Artocarpus hirsuta.*	8	*Artocarpus hirsuta.*	8	*Shorea robusta.*
9	*Shorea robusta.*	9	*Shorea robusta.*	9	*Pterocarpus Marsupium.*
10	*Pterocarpus Marsupium.*	10	*Pterocarpus Marsupium.*	10	*Pinus longifolia.*
11	*Pinus longifolia.*	11	*Pinus longifolia.*	11	*Dipterocarpus pilosus.*
12	*Dipterocarpus pilosus.*	12	*Dipterocarpus pilosus.*	12	*Abies Pindrow.*
13	*Abies Pindrow.*	13	*Abies Pindrow.*	13	*Mesua ferrea.*
14	*Mesua ferrea.*	14	*Mesua ferrea.*	14	*Picea Morinda.*

Project No. 1—contd.

No.	Green.	No.	Air Dry.	No.	Kiln Dry.
15	*Picea Morinda.*	15	*Picea Morinda.*	15	*Pterocarpus macrocarpus.*
16	*Pterocarpus macrocarpus.*	16	*Pterocarpus macrocarpus.*	16	*Cullenia excelsa.*
17	*Cullenia excelsa.*	17	*Cullenia excelsa.*	17	*Dichopsis elliptica.*
18	*Dichopsis elliptica.*	18	*Dichopsis elliptica.*	18	*Michelia excelsa.*
19	*Michelia excelsa.*	19	*Michelia excelsa.*	19	*Calophyllum tomentosum.*
20	*Calophyllum tomentosum.*	20	*Calophyllum tomentosum.*	20	*Anogeissus acuminata.*
21	*Hopea parviflora.*			21	*Michelia Champaca.*
22	*Shorea obtusa.*			22	*Dillenia pentagyna.*
23	*Pentacme suavis.*				
24	*Anogeissus acuminata.*				
25	*Lagerstroemia Flos-Reginae.*				
26	*Dillenia indica.*				
27	*Hopea odorata.*				
28	*Calophyllum Wightianum.*				
29	*Michelia Champaca.*				
30	*Dillenia pentagyna.*				

Project No. 2.

No.	Green.	No.	Air Dry.
1	*Dipterocarpus pilosus.*	1	*Picea Morinda.*
2	*Mesua ferrea.*	2	*Abies Pindrow.*
3	*Cullenia excelsa.*		
4	*Dichopsis elliptica.*		
5	*Dillenia pentagyna.*		
6	*Shorea robusta.*		
7	*Calophyllum tomentosum.*		
8	*Dipterocarpus turbinatus.*		
9	,, *alatus.*		
10	,, *obtusifolius.*		
11	,, *tuberculatus.*		
12	*Hopea parviflora.*		
13	*Shorea obtusa.*		
14	*Pentacme suavis.*		
15	*Mangifera indica.*		
16	*Hopea odorata.*		
17	*Calophyllum Wightianum.*		
18	*Pinus excelsa.*		

Project No. 4.

No.	Treated.	No.	Untreated.
1	*Cullenia excelsa.*	1	*Cullenia excelsa.*
2	*Terminalia tomentosa.*	2	*Terminalia tomentosa.*
3	,, *paniculata.*	3	,, *paniculata.*
4	*Lagerstroemia lanceolata.*	4	*Lagerstroemia lanceolata.*
5	*Dillenia pentagyna.*	5	*Dillenia pentagyna.*
6	*Dichopsis elliptica.*	6	*Dichopsis elliptica.*
7	*Cynometra polyandra.*	7	*Cynometra polyandra.*
8	*Shorea assamica.*	8	*Shorea assamica.*
9	*Dipterocarpus pilosus.*	9	*Dipterocarpus pilosus.*
10	*Lagerstroemia Flos-Reginae.*	10	*Lagerstroemia Flos-Reginae.*
11	*Dillenia indica.*	11	*Dillenia indica.*
12	*Terminalia myriocarpa.*	12	*Terminalia myriocarpa.*
13	*Bischofia javanica.*	13	*Bischofia javanica.*
14	*Castanopsis Hystrix.*	14	*Castanopsis Hystrix.*
15	*Schima Wallichii.*	15	*Schima Wallichii.*
16	*Dipterocarpusti turbinatus.*	16	*Dipterocarpus turbinatus.*
17	*Calophyllum tomentosum.*	17	,, *tuberculatus.*
		18	*Mangifera indica.*

Testing Aeroplane Woods.—Quite early in the year tests were inaugurated to determine which Indian species might be used as substitutes for Hickory in the manufacture of aeroplane tail-skids. *Anogeissus acuminata*, *Terminalia tomentosa*, *Dalbergia Sissoo*, *Grewia tiliæfolia*, *Acacia arabica*, and *Anogeissus latifolia* have already been found satisfactory and other species can no doubt be added if necessary. Near the end of the year testing of wing-spars for aeroplanes was started under Project No. 0.

The second Interim Report presenting the results of routine tests was prepared during the year. This report not only makes available the actual test results but also presents useful grading rules for Indian structural timbers, a table of working stresses which can be used in engineering design, and a tabular and graphical representation of the strengths of various species of timber in terms of the strengths of teak.

The first report prepared under Project No. 2 was also submitted during this year and presents the strengths and characteristics of Himalayan spruce and Himalayan silver fir in structural sizes and of the quality commonly placed on the market. Besides the above mentioned publications 64 technical reports, involving the submission of data on the strength and physical and mechanical properties of Indian timbers, have been issued.

3.—*Section of Wood Preservation.*

Although the main bulk of work carried out in this section has been under Project 4 a considerable amount has been done in connection with other branches of enquiry.

Project 4.—The following species have been treated under this project:—

Castanopsis Hystrix	200 M. G. sleepers for the Assam-Bengal Railway.
Schima Wallichii	200 M. G. sleepers for the Eastern Bengal Railway.
Dipterocarpus tuberculatus (*in*)	220 B. G. sleepers for the Eastern Bengal and Bengal-Nagpur Railway.
Dipterocarpus turbinatus (*gurjan*)	220 B. G. sleepers for the Eastern Bengal and Bengal-Nagpur Railway.
Anogeissus acuminata (*yon*)	220 B. G. sleepers for the Eastern Bengal and Bengal-Nagpur Railway.

The above timbers were received green and were seasoned under cover. In all 1,060 sleepers were seasoned, of which 970 were treated.

In addition 300 B. G. sleepers of *Terminalia tomentosa* were received for special experiment for the Bengal-Nagpur Railway but on arrival were found to be unsuitable. They were, therefore, treated with the ordinary mixture of creosote and earth-oil and returned to the Railway.

Preliminary tests.—These were carried out on the following species:—

Anogeissus acuminata, Stereospermum chelonoides, Terminalia Arjuna, Lagerstroemia parviflora, Calophyllum tomentosum, Anogeissus latifolia, Schleichera trijuga, Hopea cordifolia, Eugenia Gardneri, Machilus Gamblei, Bassia latifolia, Eugenia Jambolana, Mangifera indica, *Dichopsis elliptica*, *Albizzia odoratissima*, *Albizzia procera*, and *Xylia xylocarpa*. In all 146 sleepers were treated belonging to 17 species.

Sal posts.—Over 2,000 fence posts have been treated during the past year for the Silviculturist, Forest Botanist, and President, Forest Research Institute. It may be mentioned that those treated in former years and now in service show no signs of deterioration whatever.

Other work.—Sleepers of *sain* (*Terminalia tomentosa*) and *kindal* (*Terminalia paniculata*) have been treated with Wood Tar Creosote and returned to the Madras and Southern Mahratta Railway for durability tests. 20 sleepers of *Pinus longifolia* were treated with Syllit solution for the North-Western Railway and returned for durability tests.

The roof of the new shed for the Paper Pulp Section was brush treated with a mixture of Creosote and Earth Oil.

About 1,200 paving blocks for new flooring in the workshops were treated with Syllit solution and about 1,800 were treated with creosote and Earth-oil mixtures.

About 40 telegraph poles were treated in an open tank for the Mussoorie Electric Light Company.

Samples of wood under observation in the ground.—The following antiseptics were added during the year to those already under observation:—Silvertown Wood Preservative, Wood Tar Creosote and Anti-borant.

In addition a systematic experiment has been started to gauge the resistance of untreated timbers to insect attack.

The following totals give an idea of the quantity of timber treated in our small experimental cylinder.

Sleepers	1,456
Sâl posts	2,283
Flooring blocks	3,000

Laboratory work.—In the laboratory culture tests have been made to determine the relative toxicity of Wood Tar Creosote and Coal Tar Creosote. In addition a good deal of work in connection with the microscopic identification of timbers has been performed.

Tours.—Tours of inspection of sleepers in the line have been carried out by the Officer-in-Charge of the Wood Preservation Section at Lucknow, Dhilwan (twice), Ferozepore, Aligarh, Barabanki and Lhaksar.

4.—*Section of Paper-Pulp.*

Mr. W. Raitt held charge of this Section throughout the year with Mr. M. P. Bhargava as his assistant.

The paper and pulp making plant has been in operation successfully throughout the year. Several forest publications issued during the year were printed on paper made by it. The chief practical result of the year's work has been the establishment, for bamboo, of the Sulphate of Soda method of digestion combined with fractional treatment. With it the chemical cost of digestion and bleaching has been reduced by over 40 per cent. and this discovery is having a profound effect on the movement which is proceeding towards the establishment of a bamboo pulping industry in India. Its successful application to bamboo has been made possible by the erection of our experimental factory. The intention to try the method had been in hand for some years but could not be proceeded with for want of suitable plant. A summary of results obtained by it was published in June 1925.

Two manufacturing projects are now being seriously considered by substantial financial interests, one at Cuttack in Bihar and Orissa, and the other at Papanasam in Madras (Tinnevelly). Mr. Raitt recently made a second inspection of the latter area, and the bamboo available has been subjected to thorough tests in our factory with excellent results. An interim report has been given to the Chief Conservator of Forests, Madras, and to the firms interested. The supplemental report on the Cuttack project referred to in last year's report has been held back until the results of the Sulphate method could be included. It is now completed and will shortly be published by the Department of Industries, Bihar and Orissa.

The paper on which this report is printed was made in our experimental factory from *Melocanna bambusoides* bamboo. Our plant is a pulp rather than a paper making one, so we are not able to obtain quite the best results with *paper,* so far as appearances go. It would, for instance, look better if it were more closely woven and had a better surface, but the excellent quality and colour of the fibre can be clearly seen.

Sixteen requests for advice and information have been attended to. The following is a list of the more important investigations completed or in hand:—

No.	Subject.	Completed or in progress.	REMARKS.
1	*Eetta (Ochlandra travancorica) bamboo.*	In progress .	In connection with Papanasam development project. For Chief Conservator of Forests, Madras.
2	Limestone	Ditto .	Ditto.
3	Cuttack bamboo pulping project	Ditto .	For Department of Industries, Bihar and Orissa.
4	Limestone	Completed .	
5	Sulphate of Soda . . .	In progress .	
6	Grasses, mixed . . .	Completed .	For Kamat & Sons, Bombay.
7	*Sabai (Ischæmum angustifolium)* grass.	Ditto .	For Bengal Paper Mills Co., Ltd.
8	Spruce and Fir (Jaunsar) .	In progress.	
9	*Ulla (Anthistiria gigantea)* grass	Ditto.	
10	*Dendrocalamus strictus,* bamboo	Completed.	
11	*Bambusa polymorpha,* bamboo.	In progress.	
12	*Cephalostachyum pergracile,* bamboo.	Ditto.	
13	*Bambusa arundinacea,* bamboo	Ditto.	
14	*Bambvsa Melocanna,* bamboo .	Ditto.	
15	Esparto grass . . .	Completed .	A comparison with *sal* grass.
16	Sulphate of Soda digestion method.	In progress .	Its application to materials other than bamboo.
17	Effect on bleaching by different methods of digestion.	Ditto.	

5.—*Section of Timber Seasoning.*

With the exception of a few necessary stoppages for boiler cleaning and inspection, the Timber Seasoning Plant at Kaulagarh has been kept continuously at work, day and night, and on holidays—approximately 7,500 hours.

The work of the Seasoning Section is developing along three separate lines:—

1. *Pure Research* to discover the best seasoning conditions for the 70 or 80 Indian timbers which can probably be used in quantity at present.
2. *Advisory* to help Government departments and firms with their seasoning difficulties, studying their special requirements, and giving them specifications of plant required to use to the best advantage the data obtained by research work.
3. *Co-operation* with other sections of the Forest Research Institute, Provincial Forest Departments, Public Works Department, Ordnance Department, Railways, and firms in India which use timber.

1. *Pure Research.*—A process of accelerated Seasoning has been carried out during the year on the following species:—

Anogeissus latifolia	(*bakli*).
Terminalia paniculata	(*kindal*).
Lagerstroemia lanceolata	(*nana*).
Calophyllum tomentosum	(*poon*).
Tectona grandis	(Central Provinces teak).
Dipterocarpus turbinatus	(*gurjan*).
Cedrela Toona	(*toon*).
Dalbergia Sissoo	(*sissoo*).
Pterocarpus Marsupium	(*bijasal*).
Terminalia tomentosa	(*asna*).
Dalbergia latifolia	(rosewood).
Boswellia serrata	(*salai*).
Mangifera indica	(mango).
Artocarpus integrifolia	(jack).
Shorea robusta	(*sal*).
Juglans regia	(walnut).
Terminalia Manii	(black *chuglam*).
Bombax malabaricum	(*semul*).

In some cases repeat tests have been made on species tested last year with the object of getting better results or more rapid and less costly processes. In other cases preliminary trials have been made which will have to be repeated when material is available.

For the most part success has been attained, but we are faced with difficulties in the case of certain refractory species. As an example *gurjan* (*Dipterocarpus turbinatus*) in thicknesses of over 1⅓″ proved impossible to dry by ordinary means. Experiments using ozone show a possibility of getting over the difficulty. Also *sâl* (*Shorea robusta*) intended for Gun Carriage poles, is proving refractory, but successful results were obtained in June 1926.

Following last year's success with *papita* (*Sterculia campanulata*) and *Cullenia* (*Cullenia excelsa*), when fungus stains and rot were successfully eliminated, *salai* (*Boswellia serrata*), a timber proposed for match manufacture, but frequently spoilt by rapid fungus discolouration, has been seasoned successfully and without any discolouration in veneer thickness and ½″ and 1″ planks.

2. *Advisory.*—Our assistance to the Royal Ordnance Department, starting with the Royal Gun Carriage factory at Jubbulpore has been extended to the Royal Ordnance Rifle factory, Ishapore.

The seasoning installation for the Royal Gun Carriage Factory at Jubbulpore is materialising, and our assistance with the details of design has been most kindly acknowledged by the Director of Ordnance. The Timber Dryer will be at work next year and we shall give practical assistance with the working.

The Royal Ordnance Rifle Factory, Ishapore, put our claims to be able to season timbers in kilns better than can be done naturally, to a severe test by sending us 1,000 rifle halfwroughts of walnut to be seasoned. These have been dried in a satisfactory manner and we await the result of service test. If this turns out as we confidently hope, it will mean a reduction of the time for seasoning from five years to 40 days!

We have designed a dryer for a commercial concern in Rangoon which has ordered the apparatus and is now proceeding with the installation.

The Dryers installed under our advice at Olavakot in South India have been at work for a considerable time and are reported to be giving highly satisfactory service. *Cullenia* wood (which formerly was useless owing to fungus rot during air seasoning) is being turned out in the form of box shooks of excellent quality, and is commanding a ready sale for all that can be produced.

Assistance has been given to the Indian Bobbin Co. at Bareilly in the reconstruction of their existing dryer, and they report that they have now reduced the proportion of loss due to defects which developed during seasoning very considerably.

An extensive programme is in hand to season various timbers for the different Railway Workshops so that they can construct rolling stock from these timbers, properly seasoned, for service tests instead of using principally teak or imported woods as they have done in the past.

Eventually when convinced of the utility of these substitutes for teak, dryers will have to be designed for, and technical assistance given to them.

3. *Co-operation.*—Various timbers for the new Council Chambers at Delhi including rosewood, teak, *sissoo* and laurel have been received and seasoned in our Dryers and returned for manufacture.

Large quantities of Test Specimens for the Timber Testing Section have been dried to requirements.

Veneers and plywood panels have been dried and conditioned for the Wood Workshop. The kilns we have are, however, not really intended for such work, and it is hoped to procure proper specialised drying apparatus for this work during the current year.

Investigation as to the feasibility of seasoning sleepers previous to impregnation with preservatives has continued. On the one hand air seasoning experiments are being carried out to find out the loss by degrade under various conditions, on the other, an accelerated process using high vacuum has shown promise of being an economic success.

Special visits to the seasoning section have been made by the Superintendent of the Royal Ordnance Rifle Factory, Ishapore, and by the Superintendent of the Timber Section, Royal Ordnance Gun Carriage Factory, Jubbulpore; also an officer from the Rangoon Utilization Circle has spent some months at Dehra studying our methods of timber seasoning.

Seasoning process Record Guide Charts are available for the following species:—

Tectona grandis (Burma teak) up to 1″ thickness, Central Provinces teak, Deccan teak.

Terminalia tomentosa (laurel) up to 2″ thickness.

Anogeissus latifolia (*bakli*) 2″ × 2″ thickness.

Cullenia excelsa (*karani*) up to 1″ thickness.

Sterculia campanulata (*papita*) up to 1″ thickness.

Juglans regia (*walnut*) up to 2½″ thickness.

Approximate Charts can be given for:—

Dalbergia Sissoo (*sissoo*) up to 2″ thickness.

Dalbergia latifolia (rosewood) up to 2″ thickness.

Cedrela Toona (*tooñ*) up to 2″ thickness.

Lagerstrœmia lañceolata (*naña*) up to 2″ thickness.

Schima Wallichii (*makusal*) up to 1″ thickness.

Dichopsis elliptica (*pala*) up to 1″ thickness.

Mañgifera iñdica (mango) up to 1″ thickness.

Artocarpus integrifolia (jack) up to 1″ thickness.

Bombax malabaricum (*semul*) up to 3″ thickness.

Boswellia serrata (*salai*) up to 1″ thickness.

Terminalia Mañii (black *chuglam*) up to 1″ thickness.

Trials have been made with the following, and eventual success is indicated:—

Pterocarpus dalbergioides (*pádauk*) $\frac{3}{4}$″ thick.

Terminalia bialata (white *chuglam*) $\frac{3}{4}$″ thick.

Cedrus Deodara (*deodar*) 1″ thick.

Albizzia Lebbek (*kokko*) $\frac{3}{4}$″ thick.

Calophyllum tomeñtosum (*poon*) 2″ thick.

Pterocarpus Marsupium (*bijasal*) 2″ thick.

Grewia tiliæfolia (*grewia*) 2″ thick.

Heritiera minor (*sundri*) 1″ thick.

Difficulties have been experienced with three species.

Teak and *gurjun* in 1″ thickness could not be seasoned by ordinary means. Experiment with an ozone process made in France at our request gave, however, promising results with both these timbers. Research can continue if a suitable ozone plant is installed.

Sâl (*Shorea robusta*) has been processed without success, and further experiments will be necessary to assist the Royal Ordnance Department who require this material in a properly seasoned condition.

4. *Deputation.*—Advantage was taken of the visit to Europe by the Officer-in-Charge of the Seasoning Section, and he was deputed to inspect and test two entirely new processes of seasoning timber.

(*a*) Warm air seasoning with injection of Ozone (in France).

(*b*) Steam and High Vacuum drying (in Sweden).

Indian timbers were taken to France and Sweden, packed in wet sawdust and resawn just before process, so as to try the processes on material in a normal wet state.

The first process proved successful with timbers containing gums and oils, *e.g.*, *Dipterocarpus turbinatus*, but a close grained timber (*Anogeissus acuminata*) split badly. This Ozone treatment is worth further experiment in connection with several of our species.

The Vacuum process had the reverse effect, drying *Anogeissus latifolia* rapidly and with very little cracking, even in sleeper thickness. This process will be of great use in connection with sleepers that are to undergo impregnation. It is the cheapest method of extracting excess moisture from green timber and although there is a certain amount of cracking, it is not such as will affect the use of the material as a sleeper or count as degrade on a sleeper specification.

Steps are being taken to secure vacuum apparatus at the Forest Research Institute so as to continue investigation with this process.

During the absence of the Officer-in-Charge, Seasoning, in Europe, the work of the Seasoning Section was carried on by the Assistant Dr. S. N. Kapur. Confirmatory tests on timber already tried, were made successfully and new experiments started. A considerable amount of time was taken up with collecting and arranging the data from some air seasoning experiments made at Jubbulpore and at Calcutta.

6.—*Section of Wood Working.*

1. *Wood Workshops.*—This Sub-section worked on more or less the same lines as in previous years. It kept all other Branches and Sections supplied with their necessary requirements, which involved individual attention in each case as the work done was of a very varied character, and not, generally speaking, repetition.

During the year under review, 446 orders for all classes of work were received for execution in these shops, whilst jobs to the number 439 were completed.

Some idea of the work done may be gathered from the following list from which it is seen that it varied from shingling a roof, to the making of slide-rules and aeroplane tail-skids.

Items included in work turned out by the Wood Workshops:—

Office almirahs.
Filing cabinets.
Slide-rules.
Negative cabinets.
Tail-skids for aeroplanes.
Writing tables.
Show-cases.
Index Card cabinets.
Shingles for roofing.
Test tube stands.

Switch Boards.
Ladders.
Tent pegs.
Balance cases.
Callipers.
Weather-boarding.
Stools.
Benches.
Models of machinery.
Gun carriage poles.
Machine Guards.
Store-room fitments, racks, etc.

Routine work for the Timber Testing Section showed a marked increase on last year's output, the Section being supplied with 22,240 test specimens as against 16,193 specimens supplied the previous year. The specimens supplied were of great variety. The Section of Wood Technology received 290 test specimens together with 1,862 hand and Gamble specimens.

Much valuable training has been given to Indian carpenters.

2. *Sawmill.*—This department followed the usual practice of supplying the Timber Testing, Seasoning, and Wood Workshop Sections with sawn timber for tests, kiln runs and general maintenance work. Three hundred and fifty-seven logs were received and handled during the year. It has become increasingly evident that, as fine dimension sawing is more important than speed of output in research work, the existing circular rack-bench does not answer our purpose, and it has therefore been proposed to instal a horizontal single frame reciprocating sawing machine in its place. The proposed machine will give the output we require combined with good quality of outturn, with the additional advantage of a large annual saving in timber due to lower saw kerfage. At the present time it is very difficult with the circular rack saw to produce good specimens of structural beams for test purposes.

It may be stated here that, owing to the peculiar construction of the circular rack type of saw bench, no efficient automatic safety guard has hitherto been evolved. The Officer-in-Charge of the Wood Workshop Section has, however, invented such a guard and has been given permission to introduce it in this sawmill and give it a trial.

Except for cleaning and over-hauling bearings, etc., the machines in both the Wood Workshops and Sawmill worked continuously throughout the year, there being no serious breakdowns or stoppages to report.

3. *Veneers.*—The Delhi Secretariat and Legislative buildings occupied a great deal of time and attention in this Sub-Section. The panels required for these buildings are chiefly of a large area, and of such an assortment of sizes that the making of each panel requires

individual attention and matching. This, together with the fact that our equipment is not suitable for an undertaking involving panels of such big dimensions, is responsible for the length of time it is taking to execute the work. The expandable built up cores, introduced by this Sub-Section, have so far proved successful and appear to have got over the danger of uneven movement in the wood. Two hundred and ninety large panels as detailed below were completed and despatched to Delhi during the year:—

Committee Room (*padauk*)	36 panels.
Room No. 4 (*blackwood*)	75 panels.
Writing Room (*sissoo*)	68 panels.
Council of State Chamber (blackwood) . .	43 panels.
Reading Room (*kokko*)	68 panels.

The Oudh and Rohilkhand Railway were supplied with 348 plywood panels of *sissoo* for the interior of a new dining-car which they have recently built. These panels were sent to the Railway as an experiment, the object being to demonstrate the possibility of using Indian timbers in plywood form for railway coaches in this country. Due to the varying climatic conditions through which a railway coach passes during its travels, in a very short space of time, the test will be a severe one, and we await the result on the plywood panels after the first year's service.

At the request of Messrs. Vickers, Ltd., of Westminster, London, a series of Glue and Plywood tests were carried out on this firm's products, and also on plywood manufactured by certain continental firms, and supplied by Vickers for comparison. A variety of hot and cold water and mechanical shear tests were applied to the specimens sent, with the result that the British products conclusively demonstrated their superiority.

4. *Tours.*—The Officer-in-Charge of the Wood Working Section visited the carriage and coach-building shops of a number of the principal railways, and also a few private concerns, to introduce to their notice plywood made from Indian timbers, and when desired, to give them the benefit of his advice.

7.—*Sub-Section of Mechanical Engineering.*

Practically the whole of the work of the other sections depend upon the efficiency of this sub-section, as it is responsible for the maintenance of and repairs to all the machinery used.

There was only one serious breakdown during the year and this was in the tubular boiler, which has been in continuous use since the Economic Branch moved out to Kaulagarh. This is more than should be asked of any boiler, as an auxiliary is essential in such cases, to allow of periodical cleaning and overhaul. Such an auxiliary has now been installed and it is hoped that no further cessation of work for boiler repairs will be necessary.

All machines and electric motors were kept in good order and repairs made when necessary.

The hard water at Dehra Dun is still a serious difficulty and further steps are being taken to endeavour to cope with it.

The motor lorries have now been placed under the charge of the Mechanical Engineer, who is responsible for their upkeep, general running and efficiency. Since this has been done the consumption of petrol and oil has fallen considerably.

BURMA.

UTILIZATION.

(Note.—A Glossary of scientific and vernacular names will be found at the end of the Burma Report.)

Workshops.

Introduction.—The detailed report by the Forest Engineer in charge is given below for the Research Workshops. The results of the year have shown marked increase in the interest taken by the general public in the Hardwood products of Burma. This may be seen in the increase of Rs. 14,749-8-4 in the amount of furniture bought by the public. Although the demand for furniture can only have a very slight effect on the volume of Burmese Hardwoods consumed, it undoubtedly leads people to realise that our local Hardwoods can replace imported supplies, particularly for some of the larger industries in Burma, and it is to these industries that we must look at present to take up most of the outturn of our forests. The results of the sales of Hardwoods in Europe have shown that the time is not ripe for the development of a big export industry so that our chief efforts in timber research must be devoted to improving the internal demand for Hardwoods as substitutes for imported timbers.

During the year the revenue realised by the sale of articles made in the Workshops was Rs. 43,105-6-2 which is analysed below:—

	Rs.	A.	P.
Manufacture of furniture, plant, tools guards, partitions, etc., for the Timber Research Division . .	15,575	9	4
Manufacture of furniture for other Forest Divisions or Circles	7,275	4	7
Manufacture of furniture for other Government offices .	930	1	3
Manufacture of furniture for the general public .	19,324	7	0
TOTAL .	43,105	6	2

The revenue realised by the sale of articles manufactured in the Workshops during the previous year was Rs. 11,530-15-2. The increase which is mainly due to an increased demand from the public for furniture in woods other than teak is a sufficient indication that the timbers once known merely as "jungle" woods are awakening the interest they merit.

Among the principal items of furniture supplied by the Timber Research Division during the year may be mentioned the complete furnishing of the Board Room of the Rangoon Development Trust which was panelled by this Division during the previous year. This furniture was all made of *taukkyan*. It is gratifying to record that overtures have been made by the Rangoon Port Trust with a view to having the Board Room of the New Port Trust Offices panelled and furnished by this Division, and this fact indicates that the work done for the Rangoon Development Trust had found favour.

The demand for a wide variety of articles of furniture was continuous throughout the year. Office almirahs were supplied to the Registrar, Rangoon University, and office almirahs and file racks to the Officer on special duty in connection with Land Mortgage Banks. The Forest Research Library, Maymyo, was furnished with a dozen sectional book-cases, three library tables and 18 chairs—the book-cases being made of *thitsho* and *thitsi*, and the other items of *kyana* which has given every indication of being a first class furniture wood, not only as regards appearance but also on account of the ease with which it can be worked, and its comparative stability and freedom from checking and warping.

The Division provided an Exhibit of furniture and turned goods at the Burma Arts and Crafts Exhibition in February 1926 at the Jubilee Hall, Rangoon, where numerous enquiries for furniture made of such timbers as *taukkyan*, *padauk*, *sandawa*, *kyana*, *tamalan* and *kaunghmu* were received.

It is quite evident that there is a considerable public which appreciates beautiful timber and that it is only necessary for them to see furniture made with fine woods to stimulate their appreciation into an insistent demand. Once that demand has been created among a sufficiently large public one may look for signs of the various furniture manufacturers in the Province permanently entering the market for timbers other than teak.

On the 26th November 1925 a report was received from the Indo-Burma Petroleum Co., Ltd., on the *kanazo* sucker rods which this Division supplied to them last year. This report makes most satisfactory reading and the following extract from the report is given below:—

> "Although these three wells in which these rods have been put are small producers we have ample evidence, to prove conclusively that the *kanazo* rod is every bit as good as the rods we are importing from the States."

During the year steps were taken to provide a quantity of *yon* (*Anogeissus acuminata*) sucker rods to the principal users in the Oilfields with a view to having this timber put to the test of experience. A supply of this timber was cut during the year and is now being seasoned so that the *yon* sucker rods may be expected to be ready for use early in the coming year. The laboratory tests indicate that *yon* is likely to be suitable and if this indication is confirmed by the results of practical tests a very big point will have been scored. Owing to the fact that *yon* can be obtained in good quantities and of requisite size and quality it may be confidently expected to replace entirely the imported hickory rods, many lakhs of rupees worth of which are yearly imported into the province.

During the year a variety of turned handles of different kinds were made in various timbers, *viz*: *yon*, *lein*, *thitsein* and *kanazo*. The handles made included axe handles, peavy handles, hatchet handles, and hammer handles of various shapes and sizes. Orders for these were fulfilled for the Burma Railways Co., Ltd., and the Indo-Burma Petroleum Co., Ltd., who expressed satisfaction Arrangements are being made to supply sample lots of these handles to all the principal users in the Province. A consignment of 200 cubic feet of seasoned *yon* for the manufacture of handles was sent to Messrs. Martin and Co., Calcutta, as well as a sample lot of finished handles. Sample axe handles and hammer handles were supplied to the Chief Ordnance Officer, Rangoon Arsenal.

It is likely that the darkish colour which sometimes characterises *yon* timber may give rise to prejudice against it on the part of users who have always been accustomed to the very white handles of ash or hickory. But it is certain that *yon* handles can be turned out and sold at least 35 per cent. below the price of hickory and this fact will go a long way towards overcoming such prejudice. Once *yon* has been given an opportunity of proving its worth the prejudice will disappear entirely.

During the year a special Steaming Retort for preparing timber for bending was purchased but up to the end of the year it was not possible to get it erected and ready for work.

During the coming year it is proposed to test the suitability of the following timbers, among others, *tawposa, thitsein, sagawa* and *tawthayet*. It is hoped that some of these may prove suitable; for the need of a good bending timber is acutely felt in the Province. Teak, that timber of so many excellencies which at present is used for every conceivable purpose, is not at all suitable for bending. Enquiries for timbers suitable for bending have been received from the Government Dockyard, Dawbong, and from a firm in Sydney, New South Wales.

During the year 61 species of timber were used in the workshops of which the majority were merely used in very small quantities for the preparation of samples. 24 species were used in the manufacture of furniture and handles, of which *sandawa* and *kyana*, previously not worked, give every promise of being reliable and most attractive woods. The total quantity of timber of all species consumed was 5068·3 cubic feet as measured in the half wrought state and so recorded in the monthly returns as consumption. But this method of measurement, although the only practicable one, takes no account of the waste that is unavoidable. The waste in the case of stock sawn by the old mill is naturally very heavy on account of the irregular sawing. Further, in the case of a timber like *taukkyan* which has been allowed to lie in the log for sometime before being received at the mill, the waste due to shakes is very high. From the time the workshops started—August 1924—the total quantity of timber actually consumed based on actual verification of stock as on 31st March 1926 was 9883·6 cubic feet. Of this quantity only 8788·4 cubic feet was shown as consumption in the monthly returns for the period so that 1095·2 cubic feet or 11 per cent. approximately represents the waste incurred before the timber reached the half wrought stage.

Before many of these fine hardwoods of Burma can be placed on the market economically it will be necessary to reduce such waste. This can be achieved to a large extent by shortening the time that elapses between felling and conversion. Once a tree has been felled, every day that it lies in the log causes deterioration and when the days pass into months the loss is very serious.

Sawmill.

Introduction.—Below is given the report on the year's work by Mr. Watson, Forest Engineer in charge of Timber Research. It indicates that this part of the research installation which had proved most unsatisfactory in the past is now well into its stride; while the steady decrease in the cost of sawing does credit to Mr. Watson's organisation of the work.

Special mention should be made of the cordial help received from all Divisional Forest Officers in procuring supplies of the various timbers needed. Without this help so readily given progress in timber research would be almost impossible.

The work of construction of the new sawmill was started at the close of the last financial year and by 31st March 1925 only the foundations had been finished. The new mill was completed on the 15th July 1925 and started regular working on the 1st August 1925. The total cost amounts to Rs. 53,273-10-10, of which Rs. 25,105-2-2 were spent during the year under review. The amount sanctioned for the purchase and erection of the new sawmill was Rs. 67,000 so that a saving of Rs. 13,726-5-2 has been realised. The plant consists of a large double circular rack bench with a log carriage of the same type as is used for the vertical band mills, a 36″ combined chain and roller feed saw bench and two 36″ diameter pendulum cross-cut saws. The mill is operated by one 100 h. p. electric motor which drives the double rack saw and chain and roller feed bench and a 7½ h. p. motor drives the two pendulum cross-cut saws. The shafting is run in roller bearings and placed in a concrete tunnel below the floor so that there are no dangerous belts to impede free movement of material. The housing of the mill is the old tannin factory shed, which was not designed for a sawmill. But the machinery was so arranged that the progress of the timber from the log to the finished board plank or scantling was continuous thus avoiding any unnecessary handling.

From 1st August 1925, when the new sawmill started work, to the end of the year, 1,054 logs cubing 39,644·4 cubic feet *plus* 103 square ends of *pyingado* cubing 222·8 cubic feet were converted and resulted in 22,755·8 cubic feet of boards, planks and scantlings —the total loss in conversion being 42·9 per cent. Altogether 25 species of logs were dealt with, some of which presented new and difficult problems for the saw manufacturer. In the case of most of the species the quality of the sawing left nothing to be desired —clean regular smooth sawing accurately dimensioned and straight.

The consumption of inserted teeth by the double rack bench proved to be much greater than was anticipated and during the first five months of operation the full capacity of the mill could not be utilised because it was found that the 4,000 teeth ordered and supplied with the mill could not last for more than 3 to 4 months at full capacity. Fortunately this was discovered before the mill had been running a week and a further 8,000 teeth were ordered at once. These arrived late in December, since when the mill had been able to run at full capacity. Another order for teeth was placed in January 1926 and now that the rate of consumption is known no further delay should be experienced. It may be remarked that the length of service secured from the teeth depends on the kind of timber being cut, and that all the Burmese Hardwoods are much more severe on teeth than any of the timbers in the United Kingdom or in the United States of America, for which the saw teeth manufacturers principally cater. The last consignment of teeth was specially tempered by the manufacturers as a result of representations made to them by Mr. W. Watson and these have proved slightly more serviceable. With these highly tempered teeth excellent sawing results have been secured in the case of *taukkyan, padauk, yon, sit, panga, maniawga, petlezin, tamalan, petwun, thitka* and *kanyin,* as well as the more easily sawn timbers such as *thitkado, yinma,* teak, *kaunghmu, tawposa, aukchinsa* and *thitni.* Some species were encountered which treated these highly tempered teeth as if they had been made of soft iron, and these species at present may be regarded as impossible to saw economically with any saws at present available. Mr. W. A. Robertson, Conservator of Forests, Utilization Circle, refers to *thakutpo, thanthat* and *thande.* In the case of these species four small cuts of 8″ to 10″ face were sufficient to wear the saw teeth so badly that they could not be re-sharpened. *Chay* (*Gluta tavoyana*) also proved a difficult wood to saw, being both resinous and fibrous. The facts of the case have been placed before some leading saw-makers who are at present considering how this problem may be solved.

Not only the quality of the steel of which saws are made but also the size, number and shape of the teeth as well as the rate of revolution all have a decided influence on the sawing capacity, and all these points require careful examination in order to evolve a saw capable of giving really good service for all species of timber. It is probable that it will be necessary to divide the various species of timber into groups composed of species possessing similar sawing characteristics and then to design a type of saw for each group. This will take some time because experience is the only guide available, but it is an essential preliminary to the successfully milling and marketing of Burmese hardwoods. When cutting *thitni* the entire sawmill staff complained of acute irritation of the nose and throat which they firmly believed to be due to the sawdust of this species of timber. Mr. Watson was unable to experience this irritation himself but both the sawmill foreman and the store-keeper stated that their noses and throats were affected.

On several occasions considerable damage to the teeth of the saws on the double rack bench resulted from encountering iron inside logs. Fortunately most of the iron so encountered was in the form of small nails which had evidently been used to affix notices to the trunk of the tree and had then been grown over in the course of time. A large piece of iron would have destroyed the saw completely.

The cost of sawing per ton of converted timber is shown for each month below:—

August	1925	Rs.	36	8	11	per ton	of converted	timber.
September	,,	,,	48	6	10	,,	,,	,,
October	,,	,,	46	13	5	,,	,,	,,
November	,,	,,	45	10	11	,,	,,	,,
December	,,	,,	48	2	11	,,	,,	,,
January	1926	,,	37	13	4	,,	,,	,,
February	,,	,,	34	6	9	,,	,,	,,
March	,,	,,	21	11	4	,,	,,	,,

Rs. 39 15 3 average cost per ton.

If the firewood which is cut from the sawmill waste be credited to the sawmill at its market value, namely, Rs. 15 per stack of 108 cubic feet, the cost then worked out as follows:—

August	1925	Rs.	31	15	0	per ton	of converted	timber.
September	,,	,,	40	4	5	,,	,,	,,
October	,,	,,	40	6	1	,,	,,	,,
November	,,	,,	39	10	4	,,	,,	,,
December	,,	,,	42	12	6	,,	,,	,,
January	1926	,,	32	10	3	,,	,,	,,
February	,,	,,	29	3	1	,,	,,	,,
March	,,	,,	15	4	10	,,	,,	,,

Rs. 34 0 4 average cost per ton of converted timber.

It will be noticed that the cost per ton from August to December inclusive is high. As already explained this was due to the shortage of saw teeth which prevented the mill from operating at full capacity. The cost during January and February is distinctly less, but is still high, due to the fact that during these months the attempt to saw such difficult species as *thakutpo, thande* and *chay* considerably reduced the output. The figures given for March may be taken as representative for all ordinary species sawn under normal conditions.

Other works in the Timber Research Division.

During the year an overhead runway which had been purchased during the close of the previous year was put up at a total cost of Rs. 27,940, of which Rs. 10,440 were spent during the current year.

The runway connects the railway siding, the drained pond and the log pond with the sawmill, and has proved most satisfactory, reducing considerably the time and amount of labour spent in unloading logs from the railway siding, and in bringing logs from the storage ground and ponds into the sawmill.

The log pond was completed during the year at a total cost of Rs. 12,813. This pond has proved most useful in storing under water refractory timbers like *taukkyan* and *maniawga* which are particularly liable to deteriorate if stored on the ground. Such storage is the more necessary in that the bulk of the timber arrives at the sawmill between the months of January and May when the humidity of the air is at its lowest and the timber most apt to split.

The system of light railway tracks was laid down connecting up the various main buildings of the research area, *viz.*, the sawmill, seasoning and storage sheds, the dry kiln and the workshops. The cost was Rs. 7,038. The result was a considerable economy in labour and moving timber to and fro.

The road system in the research area was improved at a cost of Rs. 8,314, providing a good tarred metalled road connecting the workshops with the office and sawmill, and joining up with the main road. This road is much appreciated by the visitors to the Research Division and has undoubtedly encouraged many to come who would otherwise have stayed away.

A small portable fire-engine of the Minimax type was bought for Rs. 2,000. It can reach any part of the premises quickly and should be sufficient to deal with any ordinary outbreak of fire.

Wood Technology.

During the year under report the organisation of the various lines of research has been completed and a fairly definite programme of work has been laid out. It is still too early to report final results in most of the lines of investigation taken up, but a very useful body of information has been collected some of which is already capable of direct application.

In the section of Wood Technology the collection of type specimens of Burmese timbers has proceeded rapidly. The number of identification specimens in the collection is 196 while 546 specimen logs were received during the course of the year and are under preparation or identification—other consignments are on their way from the collectors.

The collection has already proved its use enabling accurate identifications being made of specimens of timber which have been sent in by Government officers and members of the public. Duplicate specimens from the reference collection have been sent to the Forest Research Institute, Dehra Dun, and to the Imperial Institute of Forestry at Oxford, while the balance of the duplicates have been kept to form a spare collection in Maymyo and the remainder have been stored for distribution to scientific institutions which may want them.

Timber Testing.

In the section of Timber Testing three species were sent to the Forest Research Institute, Dehra Dun, for routine tests, *viz*: *binga* (*Stephegyne diversifolia*), *pyingado* (*Xylia dolabriformis*) and *Cedrela serrata*. In regard to the latter it had been originally proposed to test timber of *Cedrela macrocarpa*, but after discussion with the Forest Botanist, Maymyo, and a reference to the Herbarium at Calcutta, it was found that *Cedrela macrocarpa* was a doubtful species, whereas *Cedrela serrata* is a definite species and one of the principal timber trees of the Shan States.

Wood Preservation.

In accordance with the joint programme of investigations arranged with the Institute at Dehra Dun the following sleepers were cut in Burma and sent for impregnation tests:—

	Sleepers
Lein (*Terminalia pyrifolia*)	210
Than (*Terminalia Oliveri*)	229
Yon (*Anogeissus acuminata*)	220
Binga (*Stephegyne diversifolia*)	22
Thadi (*Protium serratum*)	10
Leza (*Lagerstroemia tomentosa*)	19
Panga (*Terminalia Chebula*)	15
Thabye (*Eugenia spp.*)	21
Unclassified	2

The full results of these tests have not been received up to date.

As regards the possibility of developing trade in impregnated sleepers from Burma, it appears that there is little likelihood of its ever being an economic proposition. As regards internal consumption, the cost of extraction of suitable species is so close to that of *pyingado* that as long as the latter is available there will be no market for impregnated sleepers.

The Indian Railways are capable of taking up large quantities of impregnated sleepers, but the cost of extraction and delivery in India of timber from Burma is very much higher than any thing that the Indian Railways are at present prepared to pay for species other than *pyingado,* so that for the immediate future the investigation of sleeper impregnation has only rather an academic interest in Burma.

On the other hand, it is possible that there may be a field for impregnated timber in Burma to replace the more durable naturally resistant timber in constructional sizes such as are needed for the Mines and Oilfields. Hitherto these industries have relied mainly on *pyingado* and *ingyin-thitya* on account of their strength and durability. In the matter of strength there are a number of timbers available which approach very closely to those above mentioned, while the necessary durability could be obtained by impregnation and the cost of the latter should not exceed from 10 to 12 annas per cubic foot.

Teredo Experiments.—On examining the results of the teredo experiment referred to in last year's report, Mr. W. A. Robertson came to the conclusion that the information to be gained from it would never be sufficiently definite and it was, therefore, decided to abandon the lines on which it was conducted hitherto and make a new start.

Just before the close of the year the Forest Engineer in charge of the Timber Research, in collaboration with Mr. I. G. Grant, Deputy Chief Engineer, Rangoon Port Trust, organised a new experiment.

As it is now fairly certain that no timber is teredo-proof, the experiment is laid out to discover the relative rapidity of attack, the period when the attack is strongest, and the extent to which situation in respect to high water, silt deposit, current and water pollution affect the attack.

To effect this racks containing separately six species of timber have been placed in the frames of the Sule Pagoda Wharf and the Admiralty Oil Jetty, Thilawa. The timbers under test are teak, *kanyin, petwun, padauk, pyingado* and *yon,* the teak being used merely as a basis of comparison. Each month one block is removed from the frame and replaced by a new one, thus determining the cumulative effect of the attack month by month. The top block in each rack is also changed monthly thus determining the severity of attack according to season.

There are two racks for each species at each experimental station, one in shallow and the other in deep immersion.

Two years will be required for the completion of the experiment with the present set of species.

Minor Products.—Supplies of Tuba root from supposed *Derris elliptica* and *Derris uliginosa* were sent to a chemical firm in Calcutta for sale in England with a view to bringing Burma supplies into competition with that from the Federated Malay States. The product proved unsatisfactory, and an examination by the Chemical Branch of the Forest Research Institute showed the toxicity of the Burma product to be below that of the Federated Malay States.

This brings out the need for a joint botanical and chemical study of the possible Tuba root plants in Burma which will be undertaken in the coming year now that trained collectors are available.

During the year under report the principal work in connection with minor products was the beginning of the survey of the plants of Burma which yield Chaulmoogra oil. The survey has been started in response to the demand for seed of *Taraktogenos Kurzii* and *Hydnocarpus castanea,* more particularly the former.

Information as to the distribution of these species was very vague and Mr. W. A. Robertson came to the conclusion that there are possibly, if not probably, more than one species of *Taraktogenos* in Burma, and several species of *Hydnocarpus,* not to mention *Asteriastigma macrocarpa* which belongs to this family and has not been investigated. He therefore considered it necessary to make a survey of these plants combined with a chemical investigation of the oils. This has required considerable organization but the results promise to be gratifying. Three collectors have been out since November and a large number of trees have been located and marked from which botanical material is being collected and seed from each individual sent for chemical examination. The latter has been kindly undertaken by Professor D. H. Peacock of the Rangoon University.

The experiment will take two years to complete owing to the long period between flowering and the maturity of the fruit of these species, but at the end a very complete body of information should be available as well as a reliable source of seed for distribution.

In connection with this experiment the Silviculturist is investigating the germination and growth of the seed collected.

Seasoning.

Introduction.—The year under report shows steady progress in this section, the details of which are given below.

The kilns were not idle so much this year as last, and this is partly due to the improved organisation in the sawmill, which has ensured steady supplies of better quality timber than previously being available for loading, whenever the kilns were ready for them. The loading and unloading of the kilns was also accelerated by better organisation.

There has also been a reduction in the amount of firewood consumed, which is due in large measure to the fact that the whole of the sawmill waste is now available for the kilns, and this waste has a much greater value as fuel than the supplies which have had to be bought. The Officer-in-charge of the Seasoning has also been able to keep a better check on the amount consumed.

The result of the year has led to an increased interest on the part of the public in seasoned timber and indications point to our having to meet an increasing demand in this respect. At present the outturn of the kilns is only a little more than sufficient to meet the requirements of the workshops, so that there is not much scope for purely experimental workshops. Moreover, the kilns are showing decided signs of deterioration, and in view of the above a project has been put before the Local Government to build two more kilns of the Blower type, and three small experimental kilns or drying chambers to deal with the preliminary investigations which it has not been possible to carry out hitherto, but which are necessary to economise on the cost of the large scale experimental work.

In regard to air-seasoning the experiments referred to in last year's report have been carried on steadily throughout the year and an interim report on them will be published shortly.

The space available for air-seasoning and storage of converted timber has been filled to the utmost so much so that sanction has been applied for to build two more air-seasoning sheds similar to the one in existence but slightly smaller.

The detailed report of the Officer-in-charge, Seasoning, is given below :—

During the twelve months under review 31 runs were put through the kilns as against 17 for the preceding period. This large total was due in some measure to the low moisture content of some species when entering the kilns, and the consequent short period required for drying. The following list shows the species treated :—

Ananma
Chay
Kyana
Kyetyo
Maniawga
Padauk
Panga
Petlezin
Sit
Tamalan
Taukkyan
Thitka
Thitkado
Thitsho
Yon

Unmixed runs, or runs of two species only, were obtained throughout the year without difficulty. As a result the time lost through collecting and loading into the kilns pure runs was considerably reduced, and consequently the efficiency of the kilns, as compared with the previous twelve months much improved in this respect.

Certain species were found very refractory, noticeably *ananma* and *yon*. It will be seen on reference to the air-seasoning experiments that *ananma* was equally refractory under atmospheric conditions of drying.

Radical variations in the drying schedules were tried for some of these refractory species, but it cannot be said that any satisfactory schedule has yet been found.

Degrade on the whole has been successfully controlled. Many of the species dried were obtained fresh from the sawmill almost as they came off the saw, and owing to their green state possessed a high initial grading. Such a condition is very helpful to the kiln seasoning process. The refractory species above mentioned showed the only really large degrades during the process of seasoning. The largest degrades recorded were :—

	per cent.
Ananma	34
Yon	20
Chay	20

All the remaining species except *taungletkok* showed degrades of less than 10 per cent.

The system of grading in use at the Forest Research Institute, Dehra Dun, has been substituted for that formerly in use here, so as to bring results into line with those at Dehra Dun and to permit direct comparisons being made. The system is detailed in

Appendix B to Project No. IV of the Forest Research Institute, Dehra Dun.

Although the actual " fieldwork " or practical portion of the grading process is simplified in this system, the resultant calculations are much more tedious than under the old system. The existing office staff is, therefore, much taxed to keep records up to date.

The plentiful supply of timber now becoming available from the sawmill has brought about another satisfactory result, namely, that much more complete kiln loads are becoming possible. It is estimated that the maximum quantity that could have been put into the kilns during the twelve months under review would have totalled 17,360 cubic feet if the kilns had been loaded to full capacity. Actually 11,500 cubic feet were put through equivalent to 66 per cent. of the maximum. There is still considerable room for improvement here, it is true, but the present state of affairs must continue for some time yet until things are flowing sufficiently smoothly in the remaining depot departments to justify a continuous sawmill output of only uniform lengths that will exactly fill the kilns leaving no waste space.

Breakdown.—The time lost through breakdown has been eliminated almost entirely so far as the water supply is concerned. This was a large factor in delay last year. The Boiler, however, has commenced to give trouble. It has now been in operation almost continuously for some three or four years and the tubes are beginning to wear out. Twelve have been replaced within the last few months, and as the remainder are not expected to last very much longer, an estimate is being obtained for replacement of the entire lot. No other serious mechanical trouble has been experienced.

Air Seasoning.—Of the 16 species that have now been observed for over 12 months, it is at once noticeable that *ananma* is very refractory. The remaining species are all remarkable for the rapidity of their initial drop in moisture content. Within three months they had all apparently ceased drying. This condition is of course largely due to the time of year at which the experiments were commenced, and perhaps too to the comparatively low moisture content at which most of the species started the tests. It is hoped eventually to repeat the tests on each species starting at a different season of the year. *Chay* and teak are noticeable for the low range of moisture contents to which they adhere. The range of variation in moisture contents throughout the year for most of the species is very uniform and within a range of 10 per cent.

Girdling Tests.—The original scheme contemplated the eventual extraction of the species experimented upon, and their conversion and drying in the kilns at the Government Timber Depot. With the completion of the girdling portion of the experiment it became apparent that practically all the species except teak and *pyinma* had suffered too much from decay and insect attack to be worth extracting. The experiment is, therefore, being terminated at its present juncture.

Other Experiments.—At the request of the Chief Conservator of Forests, certain tests were carried out during the year on the stretching of cane " hnees " (bands for measuring logs).

Visit to Dehra Dun.—The Forest Engineer in charge of the Timber Seasoning Section, Government Timber Depôt, Ahlone, was deputed to visit the Forest Research Institute, Dehra Dun, in May 1925. Three months were spent there studying the Sturtevant Kilns and their operation. Advantage was also taken of the opportunity to observe the work in other departments at the Research Institute, and also to visit the Government Woodworking Institute, Bareilly, where a set of Tiemann Kilns and a water cooling tower are in operation. Much valuable information was obtained during the trip.

In conjunction with Mr. S. Fitzgerald, the Seasoning Specialist at Dehra Dun, a design was prepared for a battery of Sturtevant Kilns to be erected at Government Timber Depôt, Ahlone. The design and estimates for this plant, and also for a small experimental kiln, were completed and submitted for approval and sanction during the year.

A Glossary of scientific and vernacular names.

Ananma	Fagraea fragrans.
Aukchinsa	Diospyros ehretioides.
Binga	Stephegyne diversifolia.
Chay	Gluta tavoyana.
Ingyin	Pentacme suavis.
Kanazo	Heritiera Fomes.
Kanyin	Dipterocarpus turbinatus.
Kaunghmu	Parashorea stellata.
Kyana	Carapa moluccensis.
Kyetyo	Premna latifolia.
Lein	Terminalia pyrifolia.
Leza	Lagerstroemia tomentosa.
Maniawga	Carallia lucida.
Padauk	Pterocarpus macrocarpus.
Panga	Terminalia Chebula.
Petlezin	Vitex peduncularis.

Petwun	Berrya ammonilla.
Pyingado	Xylia dolabriformis.
Sagawa	Michelia Champaca.
Sandawa	Cordia fragrantissima.
Sit	Albizzia procera.
Tamalan	Dalbergia Oliveri.
Taukkyan	Terminalia tomentosa.
Taungdama	Cedrela serrata.
Taungletkok	Sterculia sp.
Tawposa	Morus laevigata.
Tawthayet	Nephelium Longana
Teak	Tectona grandis.
Thabye	Eugenia spp.
Thadi	Protium serratum.
Thakutpo	Stereospermum sp.
Than	Terminalia Oliverii.
Thande	Stereospermum sp.
Thanthat	Albizzia lucida.
Thinwin	Millettia pendula.
Thitka	Pentace burmanica.
Thitkado	Cedrela Toona.
Thitni	Amoora Rohituka.
Thitsein	Terminalia belerica.
Thitsho	Pentace Griffithii.
Thitsi	Melanorrhoea sp.
Thitya	Shorea obtusa.
Yindaik	Dalbergia cultrata.
Yinma	Chickrassia tabularis.
Yon	Anogeissus acuminata.
Zinbyun	Dillenia pentagyna.

UNITED PROVINCES.

Utilization.

Four divisions namely Jhansi, Banda, Gorakhpur and Lansdowne are now experimenting in the cultivation of lac, but it will be sometime before work can be successfully undertaken on a large scale.

CENTRAL PROVINCES.

Utilization.

The practice of working coupes departmentally as much as possible is being carried on and extended, instead of selling coupes standing to contractors.

The departmental work gives better financial results in almost every instance but an even more important point is that there is more certainty that silvicultural operations are carried out properly and within the proper period; the bugbear of extensions disappears.

PUNJAB.

UTILIZATION.

A large proportion of the outturn is extracted departmentally and the Utilization Conservator has the main control of sales.

The classification and grading of timber in sales depôts and the cutting of suitable sizes for the local markets have received attention.

Prices of coniferous timber rose considerably during the year.

Seasoning experiments are being carried out by the officers of the Forest Research Institute, Dehra Dun, for whom an open air seasoning shed was built, and to whom timbers of coniferous species were supplied. The financial loss by splitting of timber in depôt amounts to many thousands of rupees annually, and is a matter of considerable importance.

The North-Western Railway creosotes annually some 30,000 *chir*, spruce and silver fir sleepers in a most efficient modern creosoting plant. *Chir* creosoted sleepers are well reported on, but the process has not been very satisfactory in the case of the spruce and silver fir, of which there are immense supplies available at a low cost. Sleepers of these two timbers will not absorb creosote readily and the railway authorities have lately decided, on the advice of the Forest Economist, to instal an incising plant which will facilitate penetration and even distribution.

Numerous experiments have been made with the production on a commercial scale of bye-products of resin distillation such as motor grease, rosin oil, boot polish, block wax, etc., all of which by the end of the year had been successfully placed on the market. In future these bye-products will be operated by the non-official co-partner under the terms of his agreement.

The match factory at Shahdara has found the wood of *Populus euphratica* to be eminently suited for match splints and boxes, but the supply from the Multan Division is small.

Selected blue pine billets from the Punjab and North-West Frontier Province hills have been used for the manufacture of match splints and boxes, but again the supply of suitable billets is not as great as might be expected.

Silver fir logs have not as yet yielded satisfactory results, possibly because the machinery available was not suitable.

BENGAL.

UTILIZATION.

I.—GENERAL WORK OF ADMINISTRATION.

Mr. A. K. Glasson was appointed Utilization Officer with effect from 4th May 1925 in addition to his ordinary duties as Divisional Forest Officer, Darjeeling.

The Utilization Officer arranged the supply of sleepers to the Eastern Bengal Railway, and dealt with matters relating to utilization and exploitation.

Mr. Marriott, Timber Advisory Officer to the Railway Board, toured in the province in December 1925 in connection with supplies of sleepers and other timbers to Railways.

II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

Wood Technology.—Samples and specimens were supplied to the Forest Research Institute, Dehra Dun.

Timber Seasoning.—No definite experiments were undertaken at Siliguri as the new mill did not start work till late in the year.

Timber Testing.—Broad-Gauge sleepers of the following species were supplied from Buxa Division to Dehra Dun for testing after treatment:—

Machilus Gamblei (kaula)	200
Dillenia pentagyna (tatri)	200
Terminalia belerica (bahera)	15
Litsea polyantha (patmero)	15

The supply of 200 B. G. sleepers of *Stereospermum chelonoides* (*parari*) from Kurseong Division for the same purpose is in hand.

Minor Forest Products.—(*a*) *Khair* was worked for Cutch on a large scale in Buxa Division by a contractor. Preliminary experiments under the supervision of the Divisional Forest Officer, Buxa, gave a yield of 4·4 lbs. cutch per cubic foot of *khair* (solid). In all 77,618 cubic feet of *khair* were exploited and royalty of Rs. 19,328 realised, *i.e.*, approximately 4 annas per cubic foot. It was found that dead trees gave a poor yield of Cutch, as did also small trees under 3′ in girth.

(*b*) *Urena lobata* fibre was enquired for as a substitute for *jute*. Samples of the fibre were supplied and were well reported on, but so far it has not been possible to organise the collection and retting of the fibre on a commercial scale.

Paper Pulp.—The holders of the concession for bamboos from Kassalong Reserve found that extraction by their own agency was expensive. At their request the lease was put in abeyance for an indefinite period, and the forest opened to the public in the hope that cheaper supplies would be available in the open market. Results have not yet been reported.

Wood Working.—(*a*) The following timbers are under supply for railway *carriage building* experiments after kiln seasoning at Dehra Dun:—

Terminalia myriocarpa . . .	500 cubic feet (Kalimpong).
Gmelina arborea	600 cubic feet (Kurseong).

(*b*) The following were sent to the Eastern Bengal Railway works at Kanchrapara for trial use as wagon floors:—

Lagerstroemia parviflora . . .	449 cubic feet.
Schima Wallichii	867 cubic feet.

Water seasoning was recommended for the former and air seasoning for the latter.

Miscellaneous.—(*a*) *Agency.*—A proposal was received from the Planters Stores and Agency Company that we should employ them as selling agents for converted material in Calcutta. The proposal was not accepted, as it was found that the materal for which they have a sale is readily disposed of by us direct at present.

(*b*) *Mechanical Extraction.*—The skidder at Tung worked efficiently. A coupe of 37 acres in very dough irregular broken country was worked over between November and May. Over 4,000 cubic feet of logs per month were conveyed to the mill at a direct cost of Re. 0-1-6 per cubic foot for labour and materials. Very little supervision by the Forest Engineer was necessary. Depreciation of plant has not been calculated.

The Ropeway at Tung was improved by the addition of extra carriers, and the labour charge for transport of sawn timber from the mill to the Railway Siding has been 6 pies per cubic foot only.

The *skidder at Sukna* started work late on account of late felling, and the Super Sentinel tractor arrived only at the beginning of April and commenced work then.

(*c*) *Mechanical Conversion.—Tung Sawmill* was simplified and adjusted in November 1925, and ran without trouble from December to May. For a labour cost of Rs. 158 per month, the average outturn was 130 cubic feet of scantling per day. Allowing for cost of fuel, the direct cost of sawing was 1 anna per cubic foot only. The box-shook making machine has not yet arrived.

Sukna Sawmill ran from November to end of February, when it was closed down, and some of the plant and crew transferred to Siliguri.

Siliguri Band Sawmill was erected during the cold weather and commenced work at the end of March. The private mill at Siliguri has been removed.

(*d*) *Tea Boxes.*—The plant of the Buxa Timber and Trading Company (in liquidation) has been bought by a new Company (the Jalpaiguri Timber and Lead Mills Co., Ltd.) and the latter are negotiating for a lease of 40 square miles in the Buxa Forest similar to the lease originally granted to the originators of the Buxa Timber and Trading Company. Work under this new lease has not yet commenced. The new company propose to make ply-wood tea-chests and to roll tea-lead. The market for boxplanking in the hills has been adversely affected by the decision of the Railway to assess freight on the gross weight of packages instead of on the net weight of tea as hitherto. Further, boxplanking is difficult to transport and liable to damage in transit. The Shook-making machine referred to above should enable us to turn out material more easily transportable and less liable to damage in transit, and thus lead to an increased demand.

(*e*) *Matchwood.*—The lease of a block in Darjeeling Division for matchmaking, referred to in last year's report, has been given up by the lessee, who found it impossible to work it. The lease covered timber and fuel as well as matchwood and the lessee had no experience of forest work. An arrangement has now been made by which he can get matchwood only if required.

BIHAR AND ORISSA.

UTILIZATION.

Major produce.—Ten B. G. sleepers of each of the following species were sent to the Forest Economist, Dehra Dun, for strength and treatment tests:—

Terminalia Arjuna, Anogeissus latifolia, Eugenia Jambolana, Schleichera trijuga, Bassia latifolia, Mangifera indica.

At the instance of the Timber Advisory Officer with the Railway Board eighteen logs of *Terminalia tomentosa* (seven tons in weight) were despatched to the Forest Economist for kiln-seasoning and return to the Bengal-Nagpur Railway's workshop at Kharagpur, where the timber will be utilised in the construction of two railway wagons.

A scheme was drawn up for the erection of an air-seasoning shed at the Government Industrial School, Ranchi, in which various indigenous timbers will be seasoned and tested under local climatic conditions, with the further object of seeing whether markets can be found for properly seasoned timber of such species. The shed will also serve as a demonstration of how timber should be seasoned.

Samples of twenty-one species were sent to the Cottage Industries Institute, Gulzarbagh, for testing their suitability for toy manufacture.

Sabai grass.—In Chapter II reference has been made to the establishment of an experimental plot for testing the possibility of cultivating *sabai* grass as a field crop. If this experiment is successful it is hoped that we will be able to carry out the cultivation of *sabai* grass on a large commercial scale in many of the hilly tracts of forest land in the Singhbhum district, which at present support a very inferior type of *sal*.

Lac.—A note on the subject of lac cultivation in Bihar and Orissa was written by the Provincial Research Officer and published in the October, November, and December numbers of the "Indian Forester," 1925.

Work in connection with the establishment of the two brood lac farms in Palamau division, and the brood lac farm in Chaibassa division, which were referred to in last year's report, was successfully carried out according to programme. The nurseries in connection with these farms were well stocked with healthy plants which will be transplanted in the rains of 1926. Work in connection with another brood lac farm—in the Santal Parganas division—was commenced in the year under report.

Six sites for brood lac farms were selected in Manbhum and Ranchi districts. These will be taken in hand in the course of the next two or three years.

Cultivation of lac on *Schleichera trijuga*, *Acacia Catechu*, *Zizyphus xylopyra*, and *Butea frondosa* was attempted on a small scale in Sambalpur division. On *Zizyphus xylopyra* the crop again proved a complete failure, and as a result the Indian Lac Association for Research have since been asked to carry out a special investigation into the source of this failure. On the other species somewhat indifferent results were obtained, but these were due to the inexperience of the local staff in lac cultivation. One doubtful point has been satisfactorily cleared up. It was considered that the absence of lac cultivation in Sambalpur district might be due to the fact that the climatic conditions somewhat differ from those in lac districts, in that the district has about the heaviest rainfall in the province and that this takes place during two or three months. In 1925 over thirty inches of rain are reported to have fallen during July—the month of larval emergence—with hardly a single break, but nevertheless the swarming was moderately successful. This tends to prove that Sambalpur district should prove climatically suitable for lac cultivation.

The results of the year's working of the Kundri brood lac farm were fairly successful, but the irregular stocking of the area and the poor shape and size of the standing crop at present prevent full utilisation of the possibilities of the farm site. It has since been decided to improve the crop by taking portions in rotation and felling the crop thereon to get good coppice shoots, cultivating the soil, and planting up gaps.

Gum.—Tapping experiments on *Sterculia urens* were continued in Angul division until February 1926, when they were stopped as it appeared unlikely that the market value of the gum would ever be sufficient to lead to tapping on a commercial scale.

Myrabolans.—The green fruits of one hundred *Terminalia Chebula* trees were weighed in Chaibassa division. The results obtained were as follows:—

Girth class.	Yield of green fruits.
0—1′	½ seer.
1′—2′	4½ seers.
2′—3′	8 seers.
3′—4′	9½ seers.
4′—5′	10½ seers.

The weighments will be continued for two more seasons with the object of estimating the possible annual output of myrobalans.

CHAPTER V.

FOREST ENTOMOLOGY.

Central Institute.

The charge of the branch of Forest Entomology was held by Dr. C. F. C. Beeson, Deputy Conservator of Forests, Punjab, until December 1925, when, on his departure on leave, charge was taken by Mr. D. J. Atkinson, Deputy Conservator of Forests, Burma.

The charge of the post of Systematic Entomologist was held by Mr. J. C. M. Gardner, Deputy Conservator of Forests, Bengal, throughout the year.

1. *Insects attacking sal.*—(*a*) *Hoplocerambyx spinicornis.*—The large heartwood borer.—This pest continued to receive attention throughout the year. In past reports, it has been shown that the annual abundance of this beetle in Thano Working Circle, Dehra Dun, United Provinces, has been on the decrease since the control measures devised by the Forest Entomologist were put into force. That the incidence continues to decrease will be seen from the figures of the attack of 1925, when only 629 trees were found to be infested, against 1,438 in the previous year (1924). This control work is now carried on by the Division as a matter of routine, without the assistance of this branch.

In the Barkot Working Circle, Sainkot Block, in the same division, enumerations were carried out by the staff of the Forest Entomologist in the cold weather of 1925, the incidence of accumulated attack then recorded being from ·1 to 4·0 trees per acre, the attack of the year not, however, exceeding 2 trees per acre. These operations were repeated in the spring of 1926 and the total of trees recorded as insect attacked shows a welcome reduction of incidence to ·5 trees per acre. A large number of trees were, however, found dead without showing any signs of insect attack. A diseased condition of the roots indicated fungus attack and the matter has been passed to the Forest Botanist for investigation.

It is unfortunate that projected tours to investigate the threatened epidemics in Lansdowne and Kalagarh Divisions, United Provinces, did not materialise before the flight and attack of 1925 had taken place, and in consequence the lack of first-hand knowledge of the position of affairs, rendered the advice that could be offered inadequate and perhaps misleading. The difficulties were increased, in Kalagarh at least, by continual changes in the personnel. The result has been that such control measures as were attempted have been more or less ineffective, and that the attack of 1925 shows an increased severity though the figures are not really comparable with those of the previous year, both being faulty, the figures for the attack of 1924 being in reality those of the accumulated attacks up to that year. Under the impression, since thought to be mistaken, that the attack was more severe in Kalagarh, enumerations by the staff of this branch were confined to the latter Division, and it was found that, though widespread, the attack of 1925 did not much exceed one tree per acre; the maximum recorded being 1·9 (this latter compartment was, however, marked for the first time this year and the figure therefore represents the accumulated attack up to, and including, that of 1925). An inspection of the attacked area in Lansdowne indicates a more severe attack, estimated by the Divisional Forest Officer as being 2 to 3 trees per acre.

In both divisions, but particularly in Kalagarh, enumerations had taken place much too early, resulting (in Kalagarh) in a considerable number of trees being marked and felled in which attack had failed, and which are, therefore, producing perfect timber at " attacked timber " rates of royalty. Moreover, many trees showing attack at the time of inspection (March) had been missed at the time of enumeration (October onwards).

Owing to the fact of a 20 to 30 mile lead to the Railway rendering anything but the cream of the timber unsaleable, the problem with which we are faced in these divisions is considerably more difficult of solution than in the readily accessible forests of Dehra Dun, where even fuel is exportable. It is no longer a question of control bringing in revenue even at a rate much below the potential value of the trees concerned, but of a direct expenditure. This would seem to imply that in such inaccessable areas, not only is an attack of 1 tree per acre outisde the tolerable minimum, but that no attack of standing trees at all is tolerable and that the quicker an incipient outbreak is nipped in the bud the better, and the less the ultimate expenditure.

A full report on the situation has been submitted to the Provincial authorities and it has been recommended that immediate steps should be taken, before the emergence of the beetles, at the commencement of the rains, to circumscribe the area of attack in an effort to prevent the pest spreading into areas at present unaffected, as a preliminary to more serious operations next year. A properly conducted trap tree experiment has been set out in

Mandal C. 10 (Kalagarh Division), an area favourably situated for work in the rains.

(*b*) Experiments to determine the œcological succession of the fauna in *sal* (*Shorea robusta*) and laurel remained in progress throughout the year.

The monthly felling and girdling of a small number of *sal* trees has been initiated in an endeavour to discover whether the felling (or alternatively, girdling) of *sal* at any particular season renders the tree more or less subject to the attack of *Hoplocerambyx spinicornis*.

(*c*) Work continues in the Insectary on the other borers of the sapwood of *sal* and laurel (*Terminalia tomentosa*).

Reports of extensive damage by the large heartwood borer (*Hoplocerambyx spinicornis*, Newm.) were also received from Mandla and Balaghat Divisions in the Central Provinces and arrangements were made to visit the areas as soon as possible after the close of the year. (Actually visited by the Forest Entomologist in April and May 1926. The damage was found to be very serious.)

2. *Insects attacking Teak.*—(*a*) *The teak canker grub* (*Dihammus cervinus*).—Work was carried out in connection with this pest of *Tectona grandis* and *Gmelina arborea*. Sample plots were laid out in the Chittagong Hill Tracts, Bengal, and the Sylhet Division, Assam, and experiments were conducted on the lines of the protection of the stem against the oviposition of the beetle by sheathing it with cut undergrowth and by coating it with creosote, coaltar and other repellents. Results to date permit of some optimism, and, mistakes being rectified, the most hopeful measures are being tested further.

(*b*) *Defoliators.*—An assistant from the staff of the Forest Entomologist continued the teak defoliation investigation at Nilambur, Madras Presidency, until the end of September 1925, and during this period further studies of the biologies of the defoliators were made, to link up with those made by Dr. Pillai during 1924. Some 26 species have been recognised as regular teak-feeders of which three species are of primary importance; they are *Hybloea puera*, Cram. *Pyrausta machaeralis*, Wlk. and an *Arctiid sp.* The aggregate amount of damage due to the rest of the minor species collectively is capable of equalling that of either of the three primary species. *Hybloea* and *Pyrausta* run through a continuous series of 12 to 14 broods a year; the development is quickest in May and slowest during the coolest part of the monsoon and in the winter. There is no aestivating or hibernating stage;

the defoliators are permanently active throughout the year. The natural controlling factors allow a rapid increase in numbers in the course of 2 or 3 broods to the degree at which heavy defoliation or complete stripping results; the same factors cause a rapid decrease in abundance. Of these natural controls the most important are (1) the monsoon rains, (2) the production of the new foliage, (3) the parasites.

The first is accompanied by complete cessation of defoliation everywhere and is apparently the only period at which epidemics do not occur. The second is very variable in its periodic and local occurrence; and abundance of new leaves, (*e.g.*, in spring, after the monsoon, after complete stripping, after coppicing) favour the increase of *Hybloea* and their absence (*e.g.*, at the end of the year) favours *Pyrausta* and the *Arctiid.*

The third is the most facultative and is dependent on the abundance of the defoliators and of the alternate hosts of the parasites.

Parasitism was studied in greater detail, and as a preliminary to further work next season on this important sideline in the Central Provinces whether it is proposed to transfer the investigation; proposals were made and accepted for the systematic mapping of the extent and intensity of defoliation and the maintenance of increment sample plots for a period of 5 years. This work is now being carried out by a special officer deputed for the purpose by the Forest Department, Madras.

3. *Miscellaneous Pests.*—Work on the dry-wood borers *Dinoderus*, *Lyctus*, *Sinoxylon* continues. Special investigations are being carried out in connection with tent poles, etc. (bamboos) which are frequently attacked by these borers, as inquiries regarding them have been made by the Army Department.

The infestation of Army Pith Helmets by *Bostrychidæ* (*Dinoderus sp.*) has also been referred to this branch and is at present under investigation. The efficiency of paradichlorbenzene against dry-wood borers was tested. The results so far tend to show that the chemical acts differently with different insect species.

Pieces of timber treated with various wood preservatives were tested against oviposition of *Stromatium barbatum.* F. Kiricide, Anacardium shell oil, and the tar obtained from the distillations of kerosene oil for oil gas, were found effective.

On a laboratory scale immunity from attack of Ghoon borers was obtained by treating bamboo with a 10 per cent. solution of

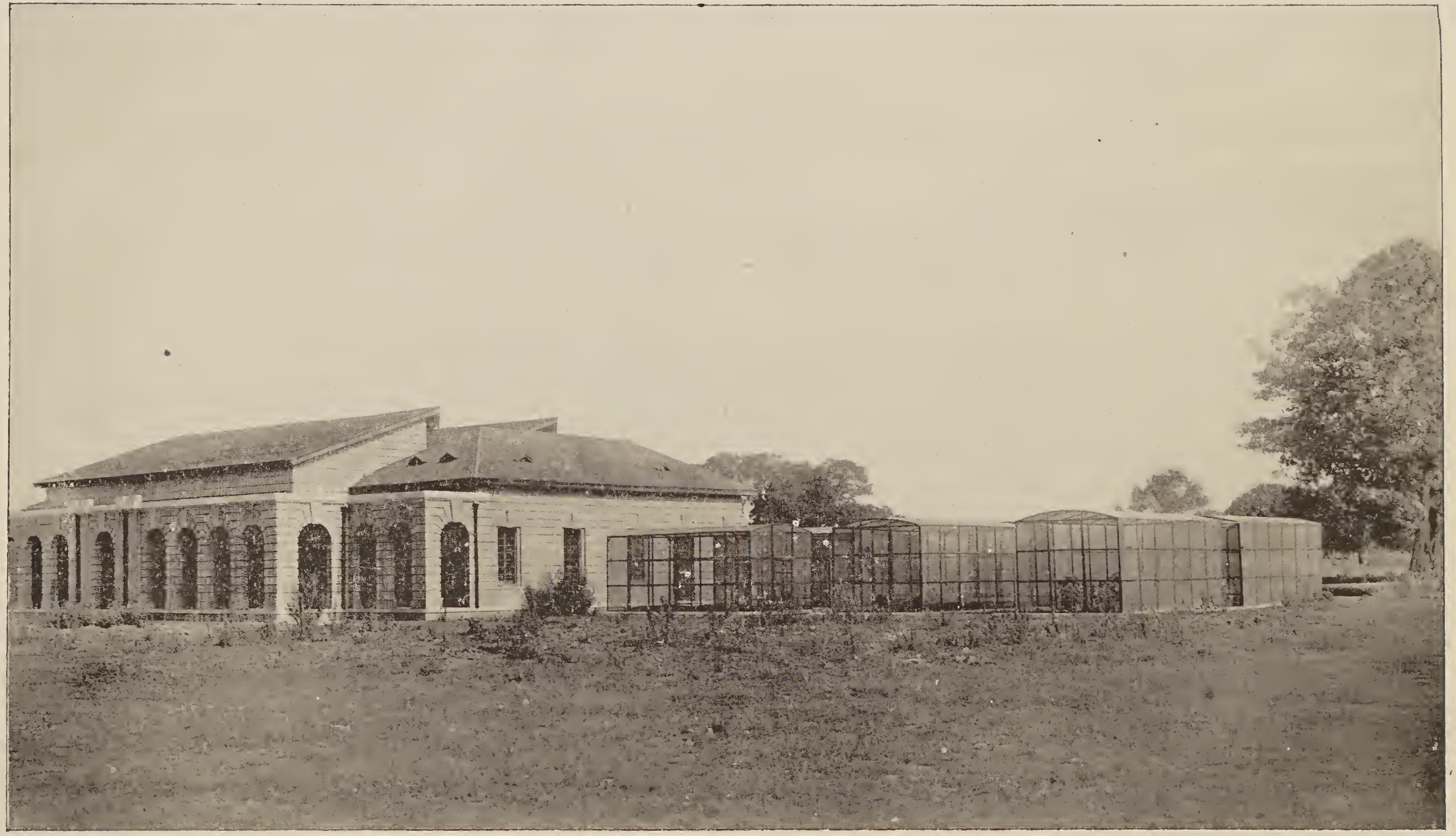

Photo. Mechl. Dept., Thomason College, Roorkee. Photo. I. N. Sharma, June 1926.

Forest Entomologist's Insectary, New Site. Forest Research Institute, Dehra Dun, U. P.

Terminalia Chebula tan extract. It is proposed to repeat the tests on a large scale next year.

4. *General Insectary Work.*—Enquiries were accompanied by 173 consignments of specimens. 467 cages were permanently occupied in rearing experiments. A total of 86,326 insects of all orders were bred out in the insectary and biological data were recorded on each specimen.

5. *Lectures.*—Lectures were given on Forest Zoology to the students of the Senior Provincial Service Class during the rains of 1925 (*i.e.*, July-October).

6. *Library.*—One hundred and ninety-one books, as well as many periodicals, were added to the Zoological Library during the year.

7. *Tours.*—The Forest Entomologist visited the Dun forests (occasional visits), Lansdowne and Kalagarh divisions in the United Provinces, in March 1926; the Chittagong Hill Tracts, Bengal, Sylhet, Shillong, etc., in Assam in May 1925; Nilambur and Bangalore in Madras, in August 1925. The Assistants visited the Dehra Dun forests throughout the year and Lansdowne and Kalagarh Divisions in February and March 1926.

Systematic Entomology.

The Insect Collection.—The collection is gradually becoming more representative of the insect fauna of Indian Forests; it may be pointed out here that *all* insect species are required, whether they are known to be pests or not and any material sent in by Forest Officers will be very useful. During the year 564 species new to the collection have been added. A considerable number of injurious insects were sent in by Forest Officers for identification and in addition useful general collections were sent by Messrs. R. N. Parker and B. Sen Gupta. About 30,000 insects were set during the year.

Most of the insects bred in the Insectary during the year were identified at Dehra Dun, but over 2,000 specimens were sent to specialists in various parts of the world for examination; most of the latter material has been received back identified. Dr. Guy Marshall, F.R.S., as Director of the Imperial Bureau of Entomology has given great assistance in arranging for the identification of various families and in addition has examined our *Curculionidæ* personally. Thanks are due to the following specialists for their assistance:—Messrs. Arrow, Blair, Crawley, Curran, Desbordes, Fleutiaux, Green, Heller, Horn, Jordon, Kleine, Meyrick, Uvarov.

The following families have been expanded:—Forficulidæ, Syntomidæ, Zygaenidæ, Niponiidæ, Trogositidæ, Erotylidæ, Endomychidæ, Cerambycidæ and Lamiidæ.

Five pairs of 20-drawer cabinets have been added for accommodation of the main collection.

CENTRAL PROVINCES.

Forest Entomology.

The *sal* borer (*Hoplocerambyx spinicornis*) is extending its ravages to an alarming extent in Balaghat and Mandla divisions. Control methods so far seem to have very little effect and the attack is worse than in 1925. The Divisional Forest Officer, Balaghat, reports an incidence of attack varying from three to eight trees per acre. The Divisional Forest Officer, South Mandla, reports finding 450 *larvæ* in one tree. He also found that this year in trees sawn up in April all stages were found, from *larvæ* just entering the sapwood to practically mature beetles, while flying beetles were seen on the 8th May. The affected areas were visited during the year by the Forest Entomologist; the seriousness of the attack is fully realised.

CHAPTER VI.

CHEMISTRY.

Central Institute.

The following is a list of the subjects sanctioned for investigation in the Chemical Branch of the Forest Research Institute during the year under report:—

Essential Oils.

1. A general study of Indian essential oils from various sources.

Oils and Fats.

2. A general study of oils and fats from Indian forest trees.

3. A general investigation into the constitution and value of dyes obtainable from barks, wood, fruits, flowers and leaves.

4. General investigation of such products as may be sent.

Essential Oil.—An interesting sample of a variety of lavender found growing in abundance in the Kurram was sent here by the

Political Agent, Kurram, Parachinar. The Forest Botanist identified the specimen as *Perowskia atriplicifolia*, Benth. A distillation test carried out in the laboratory showed that the flowers contained an essential oil to the extent of 1 per cent. The oil has been investigated by Mr. Gopal Rau, who has read a paper on the subject at the Bombay meeting of the Indian Science Congress. It is unlike the ordinary lavender oil, inasmuch as there is hardly any linanool or linalyl ester, the main constituents of the several lavender oils. The new oil is, however, of interest because of its content of bornyl esters.

Rosin.—Further investigations on the abietic acid derived from the rosin of *Pinus longifolia* have been carried out during the year, and a paper on the subject has been communicated by Mr. Rau to the Science Congress. While the present object of the study has been to find the constitution of abietic acid by oxidation and other methods, the ultimate scope of the research includes the preparation of retenequinone dyes from rosin, and for this purpose it would perhaps be possible to utilise the dark-coloured rosin which has very little market value.

Colouring Matter.—The examination of the colouring matter, morellin, present in the seeds of *Garcinia Morella,* forms the subject of a communication by Mr. Rau to the Science Congress. Apart from the chemical interest of the work, which has thrown some light on the constitution of morellin, it may be noted that, as has already been pointed out by Dr. Simonsen and Mr. Rau, the removal of the yellow colour would considerably enhance the market value of the vegetable fat derived from *Garcinia Morella.*

Alkaloid.—Progress has been made in the investigation of the alkaloid present in *Adhatoda Vasica.* Mr. Ghose has prepared a number of derivatives of vasicine and studied its constitution. It is of interest to note that in vasicine, one meets with a naturally occurring alkaloid having a quinazoline structure. It is expected to publish shortly an account of the work in continuation of the paper which had already appeared in the *Journal of the Indian Chemical Society.*

Fish poison.—An interesting reference on the subject of the toxicity of Burmese tuba root was made by the Conservator of Forests, Utilization Circle, Burma. A sample examined in the laboratory was found to be poisonous to fish, but the active principle seemed to be different from tubatoxin, the poisonous constituent of the Malayan tuba roots (*Derris elliptica*, Benth.). In view of the fact that the latter is employed by market gardeners as an insecticide, for which there is an increasing demand, it is proposed to conduct a more detailed study of the Burmese root both from the chemical and insecticidal points of view.

Analyses of samples sent by the other branches and by Forest Officers were made as usual and do not call for comment. Assistance was also rendered in some instances in the matter of making up special preparations (*e.g.*, camphor leaf emulsion for the water softener, naphthalene repellent for borers, etc.).

No tours were undertaken during the year.

A record of the analytical work done in the laboratory has been maintained.

It is the Bio-Chemist's pleasant duty to tender thanks for the willing co-operation and help received from other Research Officers in the Institute and from Forest Officers of the Department.

The equipments of the laboratory and the library seem to be adequate. The President has kindly permitted the addition of complete sets of the *Journal of Agricultural Science* and *Soil Science*.

The usual courses of lectures on Physics and Chemistry were delivered to the students of the College and their examinations conducted. The work of the students was found to be fairly satisfactory.

The current duties of the Chemical Branch were in charge of Mr. M. Gopal Rau up to the 14th October 1925. Mr. T. P. Ghose was then in charge single-handed up to the 4th February 1926 on which date Dr. J. Sen, M.A., Ph.D., was appointed Bio-Chemist, Mr. Ghose remaining as Assistant.

CHAPTER VII.

FOREST PUBLICATIONS OF 1925-26.

Serial No.	Title.	Author.	Date of Issue.
	MANUALS.		
	Issued.		
1	Elementary Manual on Indian Wood Technology.	H. P. Brown . .	February 1926.
	In Press.		
2	Manual of Forest Mensuration (Revised).	C. E. Simmons .	(June 1926).

Serial No.	Title.	Author.	Date of Issue.
	FOREST RECORDS.		
	Issued.		
3	Contributions towards a knowledge of Twisted Fibre in Trees.	H. G. Champion .	April 1925.
4	On Some Indian Brenthidae . .	R. Kleine, C. F. C. Beeson and J. C. M. Gardner.	Ditto.
5	The Constituents of some Indian Essential Oils, Part XVII.—Abietic Acid from the Rosin of *Pinus longifolia*, Roxb.	M. Gopal Rao and J. L. Simonsen.	Ditto.
6	Volume Tables for (*Tectona grandis*) Teak and (*Shorea robusta*) Sal for the Central Provinces.	V. K. Maitland .	Ditto.
7	The Economic Importance and Control of the Sal Heartwood Borer (*Hoplocerambyx spinicornis*, Newm.)	C. F. C. Beeson and N. C. Chatterjee.	May 1925.
8	Summary of Investigations on Bamboos and Grasses for Paper Pulp.	W. Raitt . .	June 1925.
9	Volume and Outturn Tables for Sal (*Shorea robusta*).	S. H. Howard .	September 1925.
10	Note on the Antiseptic Treatment of Assam Timbers for Railway Sleepers.	J. H. Warr, assisted by S. Kamesam.	November 1925.
11	Identification of Immature Stages of Indian *Cerambycidae, I. Cermabycini.*	J. C. M. Gardner .	December 1925.
12	Description of New Species of Niponiidae and Cerambycidae from India.	Ditto . .	March 1926.
	In Press.		
13	Second Interim Report on the work under Project No. I, by the Section of Timber Testing.	L. N. Seaman, assisted by C. R. Ranganathan.	(April 1926.)
14	Yield Table for Clear-felled Sal Coppice.	S. H. Howard .	(June 1926.)
15	Yield and Volume Tables for Chir	Ditto . .	(Ditto.)
16	Yield and Volume Tables for Deodar	Ditto . .	(Ditto.)

Serial No.	Title.	Author.	Date of Issue.
	FOREST RECORDS—*contd.*		
	In Press—contd.		
17	On Some Indian Cleridae (Coleoptera).	J. B. Corporral and C. F. C. Beeson.	(June 1926).
18	Notes on Artificial Regeneration in North India.	S. H. Howard .	(August 1926).
19	On Some Indian Coleoptera . .	E. Fleutiaux and J. C. M. Gardner.	(Ditto.)
	FOREST BULLETINS.		
	Issued.		
20	Note on *Ainee* (*Artocarpus hirsuta*, Lamk).	C. C. Wilson . .	April 1925.
21	Summary of results of Treated and Untreated Experimental Sleepers laid in the various Railway Systems of India.	J. H. Warr . .	May 1925.
22	Eucalyptus in the Plains of North-West India.	R. N. Parker . .	Ditto.
23	Preliminary Yield Table for *Dalbergia Sissoo.*	S. H. Howard .	August 1925.
24	Summary of results of Laboratory Experiments with different Wood Preserving Antiseptics.	S. Kamesam . .	September 1925.
25	Eucalyptus Trials in the Simla Hills	R. N. Parker . .	October 1925.
26	Tables for bark deductions from logs	S. H. Howard .	November 1925.
27	Note on the Working Qualities of some Common Indian Timbers.	H. E. Kinns . .	Ditto.
28	Chir (*Pinus longifolia*) Seed Supply.	S. H. Howard .	Ditto.
	In Press.		
29	Notes on the Comparative Economic Cost of Wood and Metal Sleepers in India, and Cost of Treatment.	J. H. Warr and H. Trotter.	
30	The Mechanical and Physical Properties of Himalayan Spruce and Silver Fir.	L. N. Seaman, assisted by C. R. Ranganathan.	

Serial No.	Title.	Author.	Date of Issue.
	OTHER PUBLICATIONS.		
	Issued.		
31	Project No. IV-Scheme of Investigations on Sleeper Woods.	R. S. Pearson, L. N. Seaman, C. V. Sweet, J. H. Warr and H. P. Brown.	May 1925.
32	Development of India's Forest Resources.	..	October 1925.
33	Progress Report of the Imperial Forest College, Dehra Dun, for the year 1924-25.	..	December 1925.
34	Lecture Notes on Minor Forest Products.	H. Trotter . .	November 1925.
35	Lecture Notes on Pulp and Paper Making.	W. Raitt . .	December 1925.
36	Lecture Notes on Timber Strengths and Timber Testing.	L. N. Seaman .	Ditto.
37	Lecture Notes on Preservation of Timber.	J. H. Warr . .	Ditto.
38	Progress Report of Forest Research Work in India for the year 1924-25.	..	March 1926.
	OTHER PUBLICATIONS.		
	In Press.		
39	Lecture Notes on Sawmill, Wood Workshop, and Tool Room Management.	W. Nagle . .	(May 1926).
40	Lecture Notes on Seasoning Timber in India.	S. Fitzgerald and S. N. Kapur.	(June 1926).
41	Project No. VII—Kiln Seasoning of Indian Timbers.	Ditto . .	(July 1926).
42	Forest Research Institute and College Calendar 1925.	..	(March 1926).
43	Progress Report of the Imperial Forest College, Dehra Dun, for the year 1925-26.	..	(December 1926.)

Contributed to Periodicals.

Anogeissus acuminata (Yon).—Report on Green Material Tested under Project No. I, by L. N. Seaman, "Indian Forester," Vol. LI, April 1925.

Testing Tail Skids at the Forest Research Institute, Dehra Dun, by L. N. Seaman, "Indian Forester," Vol. LII, March 1926.

Epicormic Branches in Sal, by S. H. Howard, "Indian Forester," Vol. LI, April 1925.

Soil Conditions under Sal, by J. N. Sen and T. P. Ghose, "Indian Forester," Vol. LI, June 1925.

The Teak Canker-grub (*Dihammus cervinus*), by C. F. C. Beeson, "Indian Forester," Vol. LI, May 1925.

The Deodar Defoliator, by C. F. C. Beeson, "Indian Forester," Vol. LI, November 1925.

The Artificial Development of Sporophores of *Polyporus gilvus*, by A. Hafiz Khan, "Indian Forester," Vol. LI, May 1925.

The Genus Sonneratia, by R. N. Parker, "Indian Forester," Vol. LI, October 1925.

A hybrid *Terminalia* (*Arjuna X tomentosa*) and some general remarks on tree hybrids, by R. N. Parker, "Indian Forester," Vol. LI, December 1925.

Fungus attack in Changa Manga, by R. N. Parker, "Indian Forester," Vol. LI, December 1925.

Burma.

Working Plan for Delta Forest Division, Burma, for 1924-25 to 1933-34, by A. W. Moodie.

Bombay.

1. Revised Working Plan for the Gund Working Circle, Kanara Western Division, Bombay, by R. A. Hemmadi.
2. Working Plan of the Scrub Forests of the Bijapur District, Bombay, by T. N. Koppikar.

United Provinces.

1. Working Plan for the Pilibhit Forest Division, United Provinces, for 1923-24 to 1932-33, by W. T. Hall.
2. Revised Working Plan for the Tulsipur Reserved Forests in Gonda Forest Division, Eastern Circle, United Provinces, for 1923-24 to 1932-33, by D. Stewart.

Bengal.

Third Working Plan for the Kalimpong Forest Division, Bengal, by J. M. Cowan.

North-West Frontier Province.

1. Revised Working Plan of the *Chil* Forests of the Lower Siran Range, Siran Division, Hazara, North-West Frontier Province, for 1923-24 to 1942-43, by E. A. Greswell.
2. Revised Khanpur Working Plan, by Pt. Mehr Chand.
3. Revised Gali Cantonment Forests Working Plan, by the same author.
4. Gidarpur Guzara Working Plan, by Khan Mohammad Khan.
5. Revised Upper Siran Working Plan, by E. A. Greswell.
6. Agror Working Plan, by the same author.

APPENDIX I.

Financial.

The expenditure of the past two years is compared below.

	Expenditure during the year.		
—	1924-25 (12 months, 1st April 1924 to 31st March 1925).	1925-26 (12 months, 1st April 1925 to 31st March 1926).	Difference (+) or (—).
	Rs.	Rs.	Rs.
AVI. Stores, Tools and Plant . . .	25,205	35,826	+10,621
AVII. Buildings, etc.	322	2,194	+1,872
AVIII. Organization, Improvement and Extension of Forest.	..	955	+955
AIX. Miscellaneous	1,64,274	1,67,733	+3,459
BIa. Conservators	61,686	45,919	—15,767
BIb. Superior Officers, Non-Voted . .	1,69,001	1,58,745	—10,256
BIb. Superior Officers, Voted . .	76,539	66,446	—10,093
BIIa. Subordinate Forest and Depot Establishment.	6,683	10,272	+3,589
BIIb. Office Establishment . . .	97,280	1,10,184	+12,904
BIII. Allowances—			
House rent and other allowances	250	400	+150
Travelling allowances . .	40,968	46,341	+5,373
BIV. Contingencies	31,459	34,380	+2,921
Total .	6,73,667	6,79,395	+5,728

Explanations of Differences between figures for 1924-25 and 1925-26.

AVI. A large water tube boiler was purchased from Messrs. Babcock & Wilcox, Ltd., Calcutta, for the Economic Branch.

AVII. Malthoid roofing was purchased for students quarters at Mundali and Kathyan and extensive repairs to these quarters were carried out.

AVIII. Seeds were sown and planting work, etc., was carried out in the Demonstration area.

AIX. Chemical laboratory was equipped with chemicals and apparatus for the Biochemist.

BIa. The President's pay was less than that of the officer who previously occupied the post. Mr. R. S. Pearson (Conservator), Forest Economist, went on leave from 1st April 1925 and Mr. C. C. Wilson, officiating Conservator, Madras, assumed charge as Forest Economist from 1st December 1925.

BIb. Non-Voted. Decrease due to Mr. S. H. Howard, Silviculturist, and Dr. C. F. C. Beeson, Forest Entomologist, proceeding on leave. They were drawing more pay than their successors; Mr. Ranganathan, Assistant Timber Testing Section, went back to Madras and the post remained vacant.

BIb. Voted. During 1924-25 Mr. P. C. Kanji Lal worked as Officiating Ecological Botanist. Mr. Gopal Rao went on deputation from 15th October 1925 to Khalsa College, Amritsar, and his post of Upper Grade Assistant, Chemical Branch, was not filled up.

BIIa. Increase due to appointment of lower grade assistant in the Silvicultural Branch and to the annual increments of other lower grade assistants in the Economic Branch.

BIIb. Increase due to annual increments of non-gazetted establishment and to the entertainment of additional temporary establishments in the Economic Branch where the work has greatly increased.

BIII. House rent, etc. Increase trifling.

,, Travelling allowances. Increase due to payment of travelling allowance on transfer to Dehra Dun of certain Research Institute Officers, Messrs. C. C. Wilson and D. J. Atkinson, and to the large amount of touring by officers of the Economic Branch.

BIV. Increase due to payment of water dues and telephone charges and purchase of books and periodicals.

A. RODGER,

President,

Forest Research Institute and College.

APPENDIX II.

Annual Form No. 24.

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION.

Summary of Revenue and Expenditure of the different Divisions during 1925-26.

Budget Heads.	President.	Silviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
REVENUE.						
II.—TIMBER AND OTHER PRODUCE REMOVED FROM FORESTS BY CONSUMERS OR PURCHASERS—						
(c) Bamboos	..	71 12 0	..	..	..	71 12 0
V.—MISCELLANEOUS—						
(a) Fines and forfeitures	..	..	..	19 0 0	..	19 0 0
(b) Refunds	20 7 0	46 2 0	46 7 0	9 15 8	860 15 0	983 14 8
(c) Other sources	6,605 8 3	2,169 8 0	138 3 4	9 2 8	2,188 15 3	11,111 5 6
TOTAL REVENUE	6,625 15 3	2,287 6 0	184 10 4	38 2 4	3,049 14 3	12,186 0 2
EXPENDITURE.						
A.—*Conservancy and Works.*						
VI.—LIVE-STOCK STORES, TOOLS AND PLANT—						
(c) Purchase of stores, tools and plant.	3,081 1 0	1,478 7 7	346 0 0	4,513 4 2	26,407 11 1	35,826 7 10
TOTAL AVI	3,081 1 0	1,478 7 7	346 0 0	4,513 4 2	26,407 11 1	35,826 7 10
VII.—COMMUNICATIONS AND BUILDINGS—						
(c) Other works	1,882 9 0	..	295 12 0	..	16 0 0	2,194 5 0
TOTAL AVII	1,882 9 0	..	295 12 0	..	16 0 0	2,194 5 0
VIII.—ORGANIZATION IMPROVEMENT AND EXTENSION OF FORESTS—						
(e) Sowing and planting.	..	798 6 0	..	..	..	798 6 0
(g) Other works	..	156 6 9	..	..	..	156 6 9
TOTAL AVIII	..	954 12 9	..	..	..	954 12 9

APPENDIX II—*contd.*

Annual Form No. 24—*contd.*

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION—*contd.*

Summary of Revenue and Expenditure of the different Divisions during 1925-26—contd.

Budget Heads.	President.	Silviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
IX.—MISCELLANEOUS—						
(c) Other charges .	11,385 15 7	7,114 8 0	3,536 1 0	2,473 13 1	1,43,222 5 8	1,67,732 11 4
TOTAL AIX .	11,385 15 7	7,114 8 0	3,536 1 0	2,473 13 1	1,43,222 5 8	1,67,732 11 4
TOTAL A .	16,349 9 7	9,547 12 4	4,177 13 0	6,987 1 3	1,69,646 0 9	2,06,708 4 11
B.—ESTABLISHMENTS—						
I.—PAY OF OFFICERS—						
(a) Conservators . .	15,000 0 0	..	21,479 0 0	..	9,440 0 0	45,919 0 0
(b) Superior Officers, Non-voted.	1,375 13 0	14,924 8 0	..	25,307 8 0	1,17,136 14 0	1,58,744 11 0
(c) Superior Officers, voted.	7,221 15 0	8,812 14 0	10,921 0 0	9,772 4 0	29,718 2 0	66,446 3 0
II.—PAY OF ESTABLISHMENT—						
(a) Subordinate forest and depot establishments.	..	1,476 0 0	..	4,745 5 0	4,050 12 0	10,272 1 0
(b) Office establishments.	16,482 10 6	15,004 8 0	8,791 2 0	13,337 0 0	56,568 11 0	1,10,183 15 6
III.—ALLOWANCES—						
(b) Houserent and other allowances.	..	..	..	..	400 0 0	400 0 0
TRAVELLING ALLOWANCES—						
(c) Conservators . .	1,043 11 0	..	455 12 0	..	2,370 1 0	3,869 8 0
(d) Superior Officers .	704 1 0	3,955 4 0	1,188 10 0	4,835 2 0	19,259 15 6	29,943 0 6
(e) Subordinate forest and depot establishments.	..	8 8 0	..	1,268 6 0	520 15 0	1,797 13 0
(f) Office establishments	..	2,290 3 0	114 10 0	669 6 0	7,656 2 0	10,730 5 0

APPENDIX II—*concld.*

Annual Form No. 24—*concld.*

FOREST DEPARTMENT, INDIA, FOREST RESEARCH INSTITUTE DIVISION—*concld.*

Summary of Revenue and Expenditure of the different Divisions during 1925-26—concld.

Budget Heads.	President.	Silviculturist.	Forest Botanist.	Forest Entomologist.	Forest Economist.	TOTAL.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Rs. A. P.	Rs A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
IV.—CONTINGENCIES—						
(*a*) Stationery	6 2 0	2 8 0	1 6 0	..	143 2 0	153 2 0
(*b*) Carriage of tents and records.	..	1,379 8 6	50 0 0	411 3 0	92 7 0	1,933 2 6
(*c*) Rents, rates and taxes.	4,425 5 6	..	48 0 0	68 8 0	3,583 0 0	8,124 13 6
(*d*) Pay of menials	1,369 8 0	..	189 3 0	54 1 0	..	1,612 12 0
(*e*) Official postage	638 14 6	250 0 0	395 4 0	400 4 0	1,118 3 0	2,802 9 6
(*f*) Sundries	7,983 10 4	1,250 7 2	2,572 2 0	3,363 7 3	2,463 7 3	17,633 2 0
(*g*) Clothing and uniform.	29 15 0	74 14 10	29 14 3	87 15 10	322 3 1	544 15 0
(*h*) Telephone	401 1 0	..	..	..	1,175 0 0	1,576 1 0
TOTAL B.—ESTABLISHMENTS	56,682 10 10	49,429 3 6	46,235 15 3	64,320 6 1	2,56,018 14 10	4,72,687 2 6
GRAND TOTAL OF EXPENDITURE	73,032 4 5	58,976 15 10	50,413 12 3	71,307 7 4	4,25,664 15 7	6,79,395 7 5
	(*a*)	1,922 9 0	650 0 0	1,531 11 0	1,720 0 0	5,824 4 0
SURPLUS OR DEFICIT	—66,406 5 2	—56,689 9 10	—50,229 1 11	—71,269 5 0	—4,22,615 1 4	—6,67,209 7 3

(*a*) These figures indicate passage pay adjusted by transfer entries in this office.

DELHI,
The 17th September 1926.

BINDRA BAN,
Assistant Accounts Officer.

Certified that the totals of this form as printed in the Forest College and Forest Research Institute Reports for 1925-26 when added together agree with those entered in the Forms for the combined offices as supplied by the Accountant General, Central Revenues, under Article 78(ii) of the Forest Department Code.

A. RODGER,
President,
Forest Research Institute and College.

APPENDIX III.

Form No. 27.

Forest Department, India, Forest Research Institute.

Outstandings and Liabilities on account of Contractors and Disbursers for the Financial year 1925-26.

Division.	Department Debtor.	Department Creditor.			Balance Due.
	Recoveries in cash and value of supplies and work done during the year.	Opening balance.	Payments made during the year.	Total.	Contractor. By———.——— Disburser.
1	2	3	4	5	6
	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.	Rs. a. p.
Silviculturist	32,790 11 9	516 9 3	32,274 3 0	32,790 12 3	0 0 6
Forest Botanist	5,275 4 6	214 2 11	5,096 3 0	5,310 5 11	35 1 5
Forest Entomologist	9,698 11 0	295 11 2	9,863 11 2	10,159 6 4	460 11 4
Forest Economist	36,137 2 5	3,191 8 10	33,499 6 0	36,690 14 10	553 12 5
Total .	83,901 13 8	4,218 0 2	80,733 7 2	84,951 7 4	1,049 9 8

Delhi,
The 17th September 1926.

BINDRA BAN,
Assistant Accounts Officer.

Certified that the totals of this form as printed in the Forest College and Forest Research Institute Reports for 1925-26 when added together agree with those entered in the Forms for the combined offices as supplied by the Accountant General, Central Revenues, under Article 78(ii) of the Forest Department Code.

A. RODGER,
President,
Forest Research Institute and College.

APPENDIX IV.

Details of Revenue of Forest Research Institute for 1925-26.

Serial No.	Details of Revenue.	President.	Silviculturist.	Forest Botanist.	Forest Economist.	Forest Entomologist.	TOTAL.
		Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.	Rs. A. P.
1	Rent of bungalows . . .	2,096 14 0	..	..	..	..	2,096 14 0
2	Interest on electric installation	293 8 0	..	..	..	..	293 8 0
3	Sale of books (chiefly Troup's Silviculture of Indian Trees).	3,927 0 6	..	..	..	..	3,927 0 6
4	Sale of bamboos . . .	..	71 12 0	..	..	..	71 12 0
5	Refunds of excess travelling allowances drawn, refunds of railway freight, etc.	20 7 0	46 2 0	46 7 0	860 15 0	10 15 8	984 14 8
6	Sale of grass from New Site .	50 0 0	..	34 8 0	..	..	84 8 0
7	Rent from Cultivators in the Demonstration Area.	..	2,000 12 0	..	..	..	2,000 12 0
8	Seeds supplied . . .	..	..	103 11 4	..	..	103 11 4
9	Miscellaneous . . .	238 1 9	168 12 0	..	2,188 15 3	27 2 8	2,622 15 8
	TOTAL	6,625 15 3	2,287 6 0	184 10 4	3,049 14 3	38 2 4	12,186 0 2

A. RODGER,
President,
Forest Research Institute and College.

APPENDIX V.

List of Forest Publications issued since the creation of the Forest Research Institute, Dehra Dun.

	Price (exclusive of packing, postage, etc.)		
	Rs.	A.	P.
I.—Bulletins (old series).			
1.—Note on the Bee-Hole Borer of Teak in Burma, by E. P. Stebbing	0	4	0
2.—Note on the Quetta Borer (*Æolesthes sartus*), by the same author	0	8	0
3.—Note on the Chilgoza (*Pinus Gerardiana*) Bark Boring Beetles of Zhob, Baluchistan, by the same author	0	8	0
4.—*Ficus elastica :* its natural growth and artificial propagation, with a description of the method of tapping the tree and of the preparation of its rubber for the market, by E. M. Coventry	0	12	0
5.—Notes on a Visit to some European Schools of Forestry, by E. P. Stebbing		..	
6.—Memorandum on Mechanical Tests of some Indian Timbers, by W. H. Everett	0	2	0
7.—Note on the Chilgoza Forests of Zhob and the Takht-i-Suliman, by E. P. Stebbing		..	
8.—Note on the Life-History of *Hoplocerambyx spinicornis* (The Singbhum Sal Borer), by the same author	0	9	0
9.—Note on the Influence of Forests on the Storage and Regulation of the Water-Supply, by S. Eardley-Wilmot		..	
10.—Note on the Duki Fig-Tree Borer of Baluchistan (*Batocera rubus*), by E. P. Stebbing		..	
11—On Some Assam Sal (*Shorea robusta*) Insect Pests, by the same author	1	10	0
II.—Leaflets.			
1.—The Sal Bark-Borer (*Sphærotrypes siwalikensis*, Steb.), by E. P. Stebbing		..	
2.—The Teak Defoliator (*Hyblæa puera*, Cram.), by the same author		..	
3.—The Teak Leaf Skeletoniser (*Pyrausta machæralis*, Wlk.), by the same author		..	
4.—The Larger Deodar Bark-Borer (*Scolytus major*, Steb.), by the same author		..	
5.—The Blue Pine " Polygraphus " Bark-Borer (*Polygraphus major*, Steb.), by the same author		..	
III.—Pamphlets.			
1.—Note on Utilisation of Khair Forests in Eastern Bengal and Assam, by Puran Singh		..	
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